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SOME ASTRONOMICAL REFERENCES FROM THE ARTHASHASTRA AND THEIR SIGNIFICANCE

BY B. R. KULKARNI, B.A.,

Curator, Rajwade Sanshodhan Mandal, Dhulia, W.K.

DR. JOLLY in his introduction to Arthashastra of Kautilya has given his opinion that the work seems to have been written in South India and that too in the 3rd Century A.D. Of course, while discussing these points and critically examining the contents of the work, he did not touch the astronomical aspects of it.

Dr. K. P. Jayaswal in his Hindu Polity (Part I, Appendix C) tried to show that he could not accept the views expressed by Dr. Jolly about the date and place indicated by this work. While doing so he made a passing reference about the astronomical element disclosed by the work.

In this short article, an effort is made to bring some of the astronomical references from this work to the notice of the scholars who are interested in the problems dealing with chronology in ancient Indian culture.

Jolly has accepted that the tables of measurements given in the work are not imaginary but they represent the actual practice prevailing at the time of the composition of the work. In the Chapter on the Measurements of space and time the lengths of the shortest and the longest days are given. They are 12 and 18 Muhurtas respectively. Each Muhurta is equal to 48 minutes. This comes to 9 hours, 36 minutes and 14 hours, 24 minutes respectively. These phenomena can only take place in Kashmir or in similar latitude in India. Not at Pataliputra a city which is nearly $25\frac{1}{2}^{\circ}$ North from equator.

Had the work been written by any Pandit from the South India, he would have naturally given the local measurements available and thus would have been detected by them. This passage from the Arthashastra is singly sufficient to indicate the place of its origin beyond any shadow of doubt. It was a place in Kashmir or N.W.F., which might have been the first Capital of the Mauryas before the Imperial Court shifted to Pataliputra. May be, it was Taxila.

•
The second point about date can also be decided from the astronomical data. The work mentions the months during which the equinoxes occurred. They are Chaitra and Ashwin for the vernal and autumnal equinoxes respectively. The summer solstice occurred in Ashadha.

It was during this month that the shadow of the gnomon was at its initial point. Jayaswal could not grasp this technical meaning of the phrase. He took it literally and wrongly suggested that the shadow of a gnomon was 0 in the month of Ashadha at Pataliputra. As stated above, Pataliputra is $25\frac{1}{2}^{\circ}$ north and no gnomon can show nil shadow on that degree at any time of the year. It is only possible within the limits of the tropics. The extent of the tropics is related to the obliquity of the earth. Unless it is proved that the angle of the axis of the earth was $25\frac{1}{2}^{\circ}$ at some time during the course of the last 2500 years the meaning of the term आषाढे मासि नष्टच्छायो मध्याह्ने भवति । means the initial shadow and nothing more. Because the summer-solstice-point was the starting point for the five year cycle calender as based on shadow of gnomon. Similarly the term अच्छायो मध्याह्ने इति । is used for indicating the everyday noon. This clearly means the initial point which is taken as a base for calculating the differences in the east or west for the daily calculation and in the south or north for the annual calculation.

India being a monsoon country the rains pour-in after the summer solstice. It does not rain at once all over India but the beginning is seen from the south. The north gets its rain after well over a month after the summer solstice. But clouds precede the rain much more early. So in the month of summer-solstice clouds appear in the sky. Kalidas records the clouds on the very first day of Ashadha in his Megha-duta. This means during Kalidas's time the summer solstice was taking place just before Ashadha and not in Ashadha as given in the Artha Shastra. Fourth century A.D. is supposed to be the date of Kalidas. Artha Shastra must necessarily go before it. Sushrit Samhita is a work which gives the season cycle synchronised with the months (Sutrasthan Chapter VI). The seasons begin with Varsha in the months Bhadrapada and Ashwin and end with Pravrisa in the months Ashadha and Shravan. The introduction of the Pravrisa as a separate season over and above the Varsha is a matter of *calender-reform* which was introduced in the Sushrit Samhita. The Pravrisa season is the monsoon rain. The Taitirya and Maitrayani Sanhitas (4-4-12) and (3-16-54, 55), respectively connect the season Pravrisa with सलिलवातमुग्रम् । i.e., the Rain Storms. This means that at the time of Sushrit, fourth century A.D., the monsoons began in Ashadha. The Artha Shastra does not include Pravrisa in the season Cycle. It begins with Varsha and that too, in Shravan. This means the actual rains did begin in the month of Shravan at that time. There is roughly a difference of a month between the commencing months of the rains in these two works.

There is another supporting reference in the same work to strengthen this view. In Chapter 122 the author classified a king's campaigns under three heads based on their duration. (1) Long term (2) Medium term and (3) Short term. Whenever a king wants to start on a long term campaign he is advised to commence it in the month of Margashirsha and Taisha (Pausha). The medium term campaign is to be started in Chaitra Vaishakh and the short term campaign was restricted to Jyeshthamuliya and Ashadha. From the last category and the months prescribed from it, it is clear a king could move his army with ease even in the month of Ashadha, and it could be only possible as it was not a month of rains then.

From these evidences about the commencement of rains in the Arthashastra and the Sushrit Samhitra we see that there is a difference of one month and mathematically it can only take place during the course of nearly 2000 years. But the modes of months' calculation, specially of the lunar type are two-fold. One ending with no-moon and the other ending with full-moon. So the difference between these two works can be shortened into the duration of a fortnight, roughly to the tune of a thousand years, and it answers satisfactorily when we assign four centuries B.C. to Kautilya and 5 centuries A.D. to Sushrit.

In addition to these the most important reference about the duration of the longest and the shortest day given by the Arthashastra shows that it was produced at a place other than Pataliputra, the famous capital of the Mauryas. It could only be possible by supposing that Chandragupta began his career as an independent sovereign in the vicinity of Kashmir under the able guidance of his famous minister Kautilya where the latter wrote his monumental work on Political Economy. And it was after him that the monarch seems to have shifted his capital to Pataliputra in Bihar, and subsequently Pataliputra came into lime light as the seat of Learning mentioned by several subsequent astronomers as Kusumpura also.

The references mentioned above from the Arthashastra and Sushrit Samhita are given below :—

अर्थशास्त्र अध्याय ४१ :—

- १ पंचदशो मुहूर्तो दिवसो रात्रिश्च चैत्रेमास्याश्चयुजे च मासि भवतः । ततः परं त्रिभिर्मुहूर्तेरन्यतरणमासं वर्धते ह्रसते चेति ।
- २ अच्छायो माध्याह्न इति ।
- ३ आषाढे मासि नष्टच्छायो माध्याह्नो भवति ।
- ४ श्रावणः प्रोष्ठपदश्च वर्षाः ।

अध्याय १२२ :—

मार्गशीर्षे तैषांतरेण दीर्घकालं यात्रां यायात् ।
चैत्रं वैशाखं चांतरेण मध्यम कालम् । ज्येष्ठामूलीयमाषाढं
चांतरेण ह्रस्वकालमुपोशिष्यन् ।

सुश्रुत संहिता सूत्रस्थान अध्याय ६ :—

इह तु वर्षा शरद्वहेमंत-वसंत-ग्रीष्मप्रावृषः षड् ऋतवो भवन्ति.....
आषाढ श्रावणौ प्रावृडिति ।

MAHA RANA PRATAP

BY PROFESSOR M. J. PATHAKJI, M.A., LL.B.,

Professor of History and Economics, Bahauddin College, Junagadh

THE ruling house of Mewad carried on for centuries a great fight against the different Muslim dynasties which were successively occupying the throne of Delhi. This struggle almost became continuous and very bitter since the time of Rana Sanga. It was Rana Sanga who gave up the usual defensive tactics of the Rajputs and went upto Sikri to challenge the conquest of Hindustan undertaken by Babar. Since that year 1527 A.D. for more than one hundred and fifty years an incessant fight went on between the Sesodias of Mewad and the Mogul Emperors of Delhi.

All these struggles were carried on with intermittent successes and reverses. It may be noted as a matter of remarkable historical significance that the Sesodia House of Mewad which had started its regime centuries before the supremacy of the Mogul Emperors in India still goes on with the same old glory and grandeur, whereas the descendants of the latter have been completely wiped out for more than 150 years.

In this long difficult fight of generations between the Mewad Rulers and the Mogul Emperors, undoubtedly the most heroic as well as the most inspiring was the one put up by Rana Pratap against Akbar. This conflict is of great importance from several points of view, all of which will be referred to here very briefly as these few lines are written by way of a general appreciation only of the great Pratap.

Pratap had to oppose one of the most remarkable kings who ever ruled India. Some consider Akbar as one of the greatest kings the world has ever seen. Whatever the historian's opinion may be, it can be definitely affirmed that Pratap had to face a very powerful adversary.

Islam had penetrated India for the preceding five centuries and the Mogul period was one of culminating glory for Islam in the country. Even during the Mogul period the regime of Akbar had a characteristic strength and grandeur. Pratap with his limited resources of men, money and material had to combat against the unlimited resources of an empire which was fast increasing its control over the whole of North India. Smith says 'the empire of Akbar during the last quarter of the 16th century was the most powerful in the world and its sovereign was immeasurably the richest monarch on the face of the earth.'

Moreover, during the sixteenth century Hindus had lost all hopes of maintaining—far less of extending their power in the whole of India. Rana Sanga's defeat at Sikri in 1527 brought to a finish for the time being, all ambitious designs of the Rajputs. Hemu's overthrow in the 2nd battle of Panipat of 1556 at the hands of Akbar demolished all ideas of a mighty Hindu revival to the five century old military and political domination of the Muslim conquerors. In addition to these disappointing events happening in North India, the battle of

Talikota fought in 1565 brought to a disastrous end the Vijayanagar Empire in South India. In this way the century was one of complete political mastery of Islam over the Hindu kings and the latter who were carrying on a mighty though hopeless resistance to overwhelming Islamic forces rushing into India had received their death-blow. Pratap came on the scene of action in 1572 A. D.—exactly at a time when the Hindus were thus already terribly submerged thrice in less than forty years—1527 to 1565—under the ever expanding flood of ocean-like Muslim conquering hordes.

Such disheartening state of things for Hindus in their own country thus brought even the proud Rajputs to submission before the might of Akbar and his Moguls. But this fact aggravated very considerably the already difficult task undertaken by Pratap. His own kith and kin went over to his opposite camp ! Those very brave and mighty Rajputs who had put up a terrific resistance for more than eight centuries, beginning from the conquest of Sind by Mahamad Kasim in 712 A.D. to the battle of Sikri in 1527 A.D., had now laid down their arms before Akbar ! It was an irony of fate that so soon after the gallant effort of Rana Sanga and the determined resistance of thousands of his Rajput warriors against Babar, the descendants of those very warriors now began to submit willingly not merely their power but even their daughters to Akbar ! Prof. Sharma writes in 'Crescent in India,' Vol. II, page 326, 'Raja Biharimal Kachhwaha' of Sambhar in 1562 (when Akbar was aged only 20) 'came with great loyalty' and 'his daughter was accepted by His Majesty.' A Hindu, much less a Rajput and still less a Rajput king would ever think of getting his daughter married to a Muslim king even forcibly and would oppose it to his last breath. Here this marriage was performed voluntarily, at the instance of the Rajput king himself !! No more surprising turn of events than this one is recorded in the whole long period of mediaeval history of our country.

We come across numerous instances in earlier Rajput history when for the sake of not giving his daughter to a Muslim monarch, a Rajput king would wage a desperate war, get thousands of his brave fighting men killed and finally if the struggle would appear fruitless, he would himself poison the same daughter and would also see that all ladies of his harem and those of his fighting men burn themselves in the terrible 'Jauhar' and thereafter would lead all his Rajput men in saffron clothes for the performance of 'Kesariya' and die to a man. A Rajput king would sacrifice everything for upholding what he regarded a matter of prestige and honour for his family.

That the inheritors of such high and noble traditions should by themselves offer their daughters in marriage to the Mogul Emperors shows clearly the depth of the feeling of hopelessness which had overcome the Rajputs of engaging into a challenging fight with the Delhi monarchs. It proves that they had lost heart in their ceaseless valiant fight of centuries against Muslim conquerors and they now became unknowingly by marriage alliances party to a scheme of empire building which had an ultimate purpose of their own destruction—an object which they could not realize at the time !

Pratap was the only Rajput who really understood this planning of Akbar and stood against it like a man. With a guerilla warfare of utmost difficulties, miseries and obstacles to himself, his family members

and his heroic fighting men, he vehemently protested by his action this attempt of Akbar to completely emasculate the Rajputs. In the vast ocean of the prevailing Rajput defeatism, Pratap firmly stood like a conspicuous beacon-light on a rock, inspiring countless generations of Rajputs who have followed him to look up to him for a noble outlook, an unrivalled determination for righteous purpose and an unparalleled capacity to suffer all possible difficulties for a cherished ideal.

It may be also emphasized that Pratap's undertaking was far more difficult, strenuous and complicated than that of Shivaji, who is generally acclaimed the saviour of the Hindus.

Pratap's kingdom was geographically much nearer to the Mogul Emperor's headquarters and therefore far more exposed to danger than Shivaji's. The latter being far away from Delhi and Agra was much safer. Besides, the vast Vindhachal range also intervened between Mogul capital and Shivaji's area of adventure.

Pratap had to challenge a king of rising fortune who was fast developing his empire. Shivaji opposed an empire wherein deterioration had already set in. The former had thus to fight against a power growing from strength to strength, the latter had to finish a weakening structure !

The army led by Akbar had still kept up the strong traditional sturdy fighting capacity of its central Asian blood, whereas the one led by Aurangzeb had lost its high fighting calibre and had grown enervated since the days of Jahangir and Shah Jehan which had brought in for the Moguls prosperity beyond measure leading to luxury and pleasures of life even among the common soldier. To fight with Akbar's army was thus much more difficult for Pratap than to break down Aurangzeb's force for Shivaji.

Pratap was single-handed in his opposition to Akbar. The other Rajput kings connected with him by a common faith and blood relationship took up the side of Akbar ! Even Pratap's own brother gave up his country's cause and went over to Akbar. The non-Rajput opponents of Akbar were also few and were easily vanquished by Akbar and his generals. Thus almost the whole brunt of a fresh and growing empire's full weight fell upon Pratap, whereas Shivaji's effort was one of the several great efforts at that time throughout India to oppose the evil deeds of Aurangzeb. The Sikhs in Punjab, the Jats and Satnamis in Central India, Rana Rajsingh of Mewad and Durgadas Rathod of Marwad in Rajputana, even in South India Bijapur and Golconda together with Shivaji were all one in not allowing Aurangzeb to have his own wishes easily carried out. The last Sikh Guru Govind Sing, opposed Aurangzeb till the latter's death, the Guru himself dying a year later in 1708. Rana Rajsing who had made Mewad too hot for Aurangzeb's vast army survived Shivaji for six months. Durgadas, the inveterate opponent of Aurangzeb, was carrying on his vigorous campaign even against the latter's successor. The kingdom of Bijapur submitted to Aurangzeb in 1686 and that of Golconda in 1687—a few years after Shivaji's demise. Thus both kingdoms carried on their wars against the Emperor in South India together with Shivaji helping each other alternately. Prof. Sharma remarks in 'Crescent India,' page 550, (Vol. II), 'In the eyes of Aurangzeb the worst offence of

Kutb Shah was his fraternising with infidels (the Marathas). Shivaji, after his flight from Agra in 1666 had received effective help from Golconda in recovering forts from the Moguls. In 1677 Shivaji was promised an annual subsidy at Haidarbad for the defence of his territory.

Pratap was helped by none except the single instance we come across of his own minister Bhamasha helping him with money. All others—Rajputs and Muslims—had joined hands to completely annihilate Pratap. The Marathas with a single voice without any defection were behind Shivaji. It required a far more powerful determination to be in Pratap's position than to be in that of Shivaji.

Both employed noble means to carry out noble aims. But among these two, Pratap may be given a higher place. Akbar's territory was so near Pratap's own. He could also have righteous indignation against his brother Rajput kings who joined Akbar and whose territories were contiguous to his own. But he did not plunder any of these territories. He only wanted to protect his own kingdom and to restore what he lost. Shivaji, on the other hand, took away several times immense treasures from Surat which was then a part and a port of the Mogul Empire. Pratap's more high-levelled ways in this way brought to him greater difficulties.

Moreover, Pratap flourished almost at the end of the great long Rajput epoch, at a time when the whole Rajput race was obviously exhausted in all sorts of resources by several centuries of single-handed deadly struggle with countless Muslim armies pouring into India from time to time. Thus an exhausted Rajput Kingdom had to oppose the might of a freshly started empire continuously rejuvenated by Muslims coming from Central Asia. Such tremendous difficulties could not be faced by even the other brave Rajput rulers and their Rajput warriors. So it was that they gave up their disastrous struggle and accepted the Mogul's domination which they thought to be inevitable. It adds volumes to the credit of Pratap that he was not overcome by such circumstances and kept his head erect and heart unnerved for a strenuously long period of twenty-five years, when all other mighty Rajputs lost their usual firmness and completely surrendered to the Moguls.

In contrast with Pratap, Shivaji had an easier problem to tackle. The latter headed a national rising of the fresh and young Maratha race, everyday gaining new vitality and had only to strike down an imperial power which had already grown dilapidated from within by its own inherent weakness.

Thus in the case of Pratap an old, exhausted devitalized Rajput race had to face the growing might of a new race of Moguls helped moreover by his (Pratap's) own kith and kin, whereas Shivaji with his fresh Maratha race had merely to pull down a tottering imperial structure which had been worn out and had become so overgrown as to be intrinsically unmanageable.

Lastly, Pratap had to oppose Akbar's policy which was apparently very tolerant but really most dangerous to Hindus. Akbar was at the time greatly admired and respected for his so called liberality by his contemporary men and his political game was followed to a great extent by the British rulers later on, accompanied by results too fresh to require any analysis here. Thus it was most difficult for Pratap to get any general sympathy from the common Hindu of the time who thought

he was exceptionally free from any religious persecution by Akbar. On the contrary, Shivaji had to oppose the religious fanaticism of Aurangzeb which naturally aroused in the hearts of the masses of the people a hatred against the intolerant Imperial religious policy. Aurangzeb could not even conciliate with the Shia Muslim Kingdoms of the Deccan. So it happened that in the task which Pratap undertook all Muslims were against him and many Hindus even not merely did not sympathize with him but actively supported the cause of his enemy Akbar, whereas in the work of Shivaji not merely all Hindus were actively helping him, but even the harassed Shia Muslims were on his side! In this way Pratap had to oppose an externally tolerant religious policy which was naturally admired by most Hindus who in those mediaeval times were unfamiliar with such apparent religious liberalism. Shivaji had to break down a fanatic and intolerant system of government which brought about the destruction of thousands of Hindu religious places of worship, a state of things bringing bitter resentment in the hearts of all Hindus, and thus evoking a far more popular approval for his challenge to the Empire.

The work of both Pratap and Shivaji has been mighty and tremendous. Both have been very great in their own way, but if we compare the two and the circumstances under which they were placed and had to carry out their work, it can be definitely laid down that Pratap's task was certainly an uphill one. His achievements were more difficult of accomplishment, more strenuous in their execution, hindered by many more adverse circumstances and brought about in the midst of far fewer favourable environments than those of Shivaji.

Generations after generations have passed since the death of Pratap but he has remained immortal. No sooner as Akbar, the greatest Mogul Emperor is remembered, immediately the memory of Pratap becomes fresh. Even otherwise his memory is imperishable. He has always been the ideal of the Rajputs in general and their kings in particular.

The Hindus have the time-old convention of giving their children the names of the persons whom they look up to as models. When the Hindus very much respect some one, they assign his or her personal name to their newly born children. In this way Rama, Lakshman, Bharat, Krishna, Bhim, Arjun, Karna, Sita, Jasoda, Anasuya have been adopted for many as their proper names. So it has been with regard to Pratap. Since his days many Rajput kings, numberless Rajput commoners and thousands of other Hindus have been named as Pratap. Rana Pratap thus lives as Pratap in the memory of countless people, who consciously or otherwise remember his great name and his immortal work and go on paying their tribute to a man enshrined permanently in their hearts, by constantly reciting his name.

Till the days of Pratap, the kings of Mewad were styled as Ranas, such as Kumbho Rano, Rana Sanga, Rana Udaising. But the work of Pratap was considered so remarkable by the people that in endearment and in appreciation of his greatness, he was given the appellation of 'Maha' Rana Pratap—meaning the 'Great' Rana Pratap and this title has been ever attached to the rulers of Mewad since his day.

Such was Pratap who ascended the throne as a Rana but died as a Maha Rana! He more than merely justified his name which signifies 'force' or 'power.' He was Pratap in name and he became Pratap in fact!

THE RANIPARAJ PROVERBS

By DR. D. P. KHANAPURKAR, M.A., PH.D.

THE forest tribes of South Gujarat who are famous as Raniparaj have a vast store of proverbs. And if the famous line of Shakespeare "Brevity is the soul of wit" is taken as a standard for judging the intelligence, the Raniparaj proverbs would afford a little chance to Raniparajs for being grouped as "Backward."

The Raniparaj proverbs, which mean more than they express, bring out to the full, the wisdom and intelligence of the Raniparaj. Their life, being one of hardship and labour, a large number of proverbs deal with the importance of labour. Some of these are :—

Translation

- | | |
|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| 1) Udyama karavā ta dukāḷa nahi
Aḷasāicā dukāḷa āhe. | 1) Labour removes famine. Famine
is for idlers. |
| 2) Mehanata karashi ta jagashi Meha-
nata na karashi ta vāryāvara marashi. | 2) One can live by working. If one
does not work, Death will be the result. |
| 3) Kashtanā paisāk hāvā, harāmanā
nahi. | 3) Eat the earnings of labour and not
of idleness. |
| 4) Peṭa kare veṭha. | 4) The belly compels one to work. |

The Raniparaj are of the opinion that work must be coupled with intelligence, hence

- | | |
|-----------------------------------------|----------------------------------------------------|
| 5) Akkala dharashi ta poṭabhara khāshi. | 5) If one has intelligence, one can get
enough. |
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And this intelligence must not be without earnestness and willingness to work personally, because

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| 6) Padarashivāya kadara nahi Jātashi-
vāya jatrā nahi. | 6) None is known, but one's work.
None can see a fair, without going. |
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or

or

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| 7) Padara maravā, saraga dekhavā
Padara rābhavā, anājani rāsa dekhavā. | 7) For seeing heaven, one must die.
For getting a heap of corn one must
work hard. |
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While the following three proverbs stress the importance of responsibility for one's deeds.

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| 8) Jo karaha to bharaha. | 8) One who does, must suffer. |
| 9) Māraṇa hoke taraṇa ho ; padara
karavā padara jāvā. | 9) Let there be death or safety ; one
should face the consequences. |
| 10) Karanā chuṭakā ke maranā chuṭakā. | 10) One must do and bear the result. |

The economic life of Raniparaj is far from satisfactory, and the following proverbs illustrate this point amply.

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| 11) Kukaṇā ca nādanā Amasapunavecā cāndanā. | 11) The life of Kukana resembles the phases of moon. |
| 12) Miṭha hāya ta piṭha nāya Piṭha hāya ta miṭha nāya. | 12) If he has salt, he is short of flour. If he has flour, he has no salt. |
| 13) Khaḷe tā sudhi gale Kaṇage tā sudhi raṇage. | 13) The corn flows till the threshing floor is empty. The man enjoys till it is in store. |

Then he has no go but to seek a moneylender, though he knows that—

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| 14) Sāvakarīnā dagaḍa ghogivara jaḍa basaha. | 14) Debt of moneylender is like a heavy stone round the neck. |
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Naturally a landlord in the Raniparaj village is considered a man of importance. And he has a number of serfs, serving for him, hence—

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| 15) Vastivara masti. | 15) His strength lies in man power. |
| 16) Ekajaṇāci vasti ghara calaha nahi. | 16) He alone cannot run a show. |

Yet his presence is considered essential for supervision. otherwise—

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| 17) Dhaṇi nahi pāsa, khetici nāsa Dhaṇi pāsa, ta khetici āsa. | 17) Absence of landlord means ruin of crop. His presence means hope. |
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The greatest vice of the Raniparaj is his fondness for drink. He makes every occasion an excuse for drinking. Yet the proverbs extol the virtues of temperance.

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| 18) Dāru āpaṇa khāvā Dāru āpaṇālā khāya ta āpaṇa māṇuḥa kāsanā. | 18) We should drink liquor. If liquor drinks us, we are not men. |
| 19) Dāru pivā na sāṅgavā mā mothā Dāru utari jāhā ke phadiyā sāpaḍaha nahi. | 19) Drink and shout that I am King. Afterwards the pockets are empty. |

The drink leads to brawls and quarrels. During these quarrels, one is likely to hear the following proverbs—

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| 20) Nijela vāghalā jāga kari didhi. | 20) You have aroused a sleeping tiger. |
| 21) Puchaḍivara pāu thevaha tahā sāpa cāvaha. | 21) A snake bites, when its tail is pressed. |
| 22) Saraḍāni dhāva kupipāvata Rāgini dhāva goṭhaṇa pāvata. | 22) A chameleon's run extends to hedge. An angry man's to cattleshed. |
| 23) Huila te jāila. | 23) Let anything happen. |
| 24) Māni abaru bharina tahā pāgaḍi bāndhina. | 24) When I will regain my honour I will put on my headgear. |
| 25) Fojadāricā nātā gharamā nahi jātā. | 25) Related with a police officer and no grinding wheel in a hut, i.e.—Braggard. |
| 26) Kutarāvara kutarā ṭākavā nahi. | 26) A dog must not be let loose against a dog. |

- 27) Sangulā ta angāvara culā. 27) I am advising and you are pouncing on me.
- 28) Harahara bhusa, kārabhāra phusa. 28) Hasty conclusions, result nil.
- 29) Shahāñāni eka bāta murakhani sāri rāta. 29) Wise speak once, fools throughout the night.
- 30) Dona disa rahanā, gava kai lahānā. 30) To stay for two days and to question, "why the village is small?"
- 31) Madhalā bailālā sāisa mārāha. 31) Driver beats the middle bullock, *i.e.*, one who tries to separate the fighters.

The occupation of Raniparajs is agriculture, and they anxiously await rainfall at the constellation of Citra, to have abundant crop. They say :

- 32) Varase cita, bhāge bhita. 32) Rainfall at Citra brings overflow of grain.

Generally the Raniparaj proverbs, like other proverbs are ethical. A few of these are cited here.

- 33) Jasā sanga tasā ranga. 33) As the company, so the pleasure *i.e.*, a man is known by the company he keeps.
- 34) Mana jaḷaha ta mana jāṇaha Dhura nighaha ta jaga jāṇaha. 34) If mind burns, mind knows. If there is smoke, then others know, *i.e.*, one knows one's own mind.
- 35) Rāja rāja karaha, duniyā majāmā jagaha. 35) The king rules and the people enjoy, *i.e.*, one toils and others enjoy.
- 36) Puḷhe puḷhe maraṇa nako citāra. 36) Don't paint always a picture of death, *i.e.*, do not be disheartened.
- 37) Gāḍā cālaha ta gāḍā nāhita maḍhā. 37) If it moves it is a cart. If not, it is a dead thing.
- 38) Gharobala ghara dyāvā, hisābalā nita rahevā. 38) Give a house to a friend. But do not omit farthing from account, *i.e.*, be particular in business.
- 39) Shikavaha to mābāpa, uḷavaha to vairi. 39) One who advises is father ; one who puts off is enemy.
- 40) Eshi varasa jagaha to purusha sham-bhara varasa jagaha to murakha. 40) One who lives eighty years is a man. One who lives hundred years is a fool. (As advance age brings untold sufferings).
- 41) Pāca lākaḍāni dhuṇi peṭavaha ta duravara nijavā. 41) One should sleep away from fire when five logs are burning, *i.e.*, keeping away from public scandal.
- 42) Herāyaja ta sāṅgāyaja, bharamasāṭa kasā sāṅgāyaja. 42) One should tell what is seen and not what is heard.
- 43) Duranā ḍungara shobhi disaha Naji-akanā ḍungara gāṇḍi disaha. 43) Mountains appear lovely from distance but ugly from near, *i.e.*, Familiarity breeds contempt.

44) Disalā deva phīṭalā navasa ājapā-
suna shikabudha lāgani.

44) Saw the God, kept the promise, from
today I follow the teaching, i.e., I have
understood the law by warnings and
punishment.

45) Āiti bhali āshavaṇa.

45) Reserve is useful in times of need.

Like Wordsworth, a Raniparaj proverb declares—

46) Bāpa beṭā pāsuna janamaha.

46) Child is the father of man.

As the Raniparaj believe that a dead person is reborn as the son of his son.

Such is this aboriginal Raniparaj tribe. In their own words, they declare—

47) Āmi asala jāta tumi anāḍu jāta.

47) We are original you are not.

And how can one, who knows ancient history can deny their claim to originality in matter of habitus as well as valour and intelligence?

DASĀVATĀRA CITRA

Gujarati Painting in the Seventeenth Century

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I

THAT Gujarat held a distinguished place in artistic achievements in ancient and mediaeval India is now an established fact. It particularly excelled in the art of painting. All great masterpieces of ancient Indian painting come from the Northern Deccan and the western border of Mālwa, which almost touches Gujarat.¹ Numerous records are now available, which point to the skill of the Gujarati artists in painting, sculpture and other arts. A Tamil poem *Manimekhalai*, attributed variously between the 1st and the 6th century A.D., tells us that the painters of Lāṭa, as well as of Kosala, were renowned for their skill all throughout the country.² At another place it refers to sculptors from Vardhamānapuri, which, according to Mr. N. C. Mehta, may be perhaps modern Wadhvān in Kāthiāwād.³ The famous Bagh fresco, where women are shown as moving round in a group dance with little sticks in either hand, evidently keeping time with the lilt of the song,⁴ is definitely a depiction of the celebrated *dāṇḍiā rāsa*, which is a feature peculiar to Gujarat. The artists who executed the scene must have been in all probability Gujaratis. The distinctive characteristics of the Gujarati painting—the three-fourths profile with the further eye bulging out from the facial outline, and the pointed nose—are also evident in the frescoes of Elura, 8th century A.D.⁵ The three-fourths profile is met with even earlier in the frescoes of Ajanta, 6th and 7th centuries A.D.,⁶ and of Sigiriya, Ceylon, 5th century A.D.⁷ It is possible, in the opinion of some art-critics, that the painters of Gujarat may have been responsible for the frescoes of Ajanta and Elura.⁸ From a refer-

¹ Vide *The Bagh Caves in the Gwalior State*, pub. India Society, London, 1927, p. 4; N. C. Mehta, *Studies in Indian Painting*, Bombay, 1926, p. 21.

² *Manimekhalai*, of Śittalai Śattanār, trans. Krishnaswamy Aiyangar, p. 159; cited by N. C. Mehta, *Gujarati Painting in the Fifteenth Century, A Further Essay on Vasanta Vilāsa*, p. 25.

³ N. C. Mehta, *A New Document of Gujarati Painting—A Gujarati Version of Gita Govinda*, *Journal of the Gujarat Research Society*, October, 1945, p. 139 f.n. Note—Other scholars consider that Burdawan in Bengal represents the ancient Vardhamānapuri.

⁴ Vide *The Bagh Caves* Plates D & E ('The Fourth Scene').

⁵ Vide the figure of Lakṣmī on the ceiling painting of the Kailāsa temple, Elurā. Plate LVII, figure 196, *History of Indian and Indonesian Art*, by Dr. Ananda K. Coomaraswamy, London, 1927.

⁶ Coomaraswamy, *op. cit.*, pl. XLVIII, fig. 179 and 180.

⁷ Coomaraswamy, *op. cit.*, pl. L, fig. 184.

⁸ N. C. Mehta, 'The Pictorial Motif in Ancient Indian Literature,' *Journal of the Bihar and Orissa Research Society*, Vol. XII, Pt. IV (1926), p. 501. Note—Other scholars, however, believe that the Ajanta and Elura frescoes were executed by Vākātaka artists and early Caulukya painters.

ence in Pādatāḍitakam, a mediaeval burlesque by Syāmila, it appears that the residents of Lāṭa and Saurāṣṭra were known for their pursuit of sculpture and painting.⁹ Somadeva, 11th century A.D. describes Lāṭa as the very home of arts.¹⁰ The Tibetan historian Tārānāth, 1608 A.D., refers to a school of painting of the 'Ancient West' in vogue in the region of Gujarat and Rājputānā in the 7th century.¹¹ Gujarati painting is in the direct line of descent of the older fresco-paintings of Ajanta and Elura and a continuation of the style of the 'Ancient West.'¹²

This level of high artistic achievement appears to have been maintained during the succeeding period of the Muhammedan rule in Gujarat. The Gujarati School of architecture showed remarkable achievements in the reign of Mahmud Begarha (1459-1511 A.D.), and penetrated to the surrounding country,¹³ and in the days of Akbar 'Gujarati' became an epithet of distinction among painters and artisans.¹⁴

II

The School of Gujarati painting dates from c. 1100 A.D. It is in the form of illustrated manuscripts, religious and secular, first on palm-leaf (1100-1400 A.D.), and then on paper (1400-1650 A.D.)¹⁵ The old murals are no longer in evidence. The illustrated Mss are mostly religious, a bulk of them being Jaina *Kalpasūtra* Mss, though there have been some Vaiṣṇava and Śākta Mss as well, which have recently come to light.

The Jaina *Kalpasūtra* and *Kālakācārya Kathā* Mss were the first illustrated Mss to be brought to light and studied by scholars. It is for this reason that scholars were inclined to regard the art of these miniatures as Jaina art. Coomaraswamy first called this art the Gujarati School of Jaina hieratic art, distinguishing it from the Hindu art, represented by the Rajput schools of Rājasthān, Jammu, Kāngrā and Garhwāl, the Shikh school, and the Orissan School of Vaiṣṇava book-cover paintings, all of which drew their inspiration generally from Vaiṣṇavism.¹⁶ Professor W. Norman Brown first called this style Śvetāmbara Jaina, as the miniatures in this style were, till then, found in the Mss of that community only. Later, finding it difficult to ascertain whether this art originated exclusively among the Śvetāmbaras, he suggested the name 'Western Indian' to denominate this school.¹⁷

⁹ *Caturbhāṇi*, ed. D. G. Śarma and Krishna, Bakergunj, Patna; cited by N. C. Mehta, *GPFC (Gujarati Painting in the Fifteenth Century)*, p. 29.

¹⁰ *Kathāsaritsāgara*, tarāṅga 74, vss 138-139 :

देशं स छाटविषयं कदाचित्प्रापदेककः ॥ यत्रासंकीर्णवर्णोऽपि जनश्चित्रोज्ज्वल-
स्थितिः । निलयोऽपि कलानां यो न दोषाकरशब्दभाक् ॥

¹¹ N. C. Mehta, *SIP (Studies in Indian Painting)*, p. 22.

¹² A. K. Coomaraswamy, *HIA (History of Indian and Indonesian Art)* p. 121; N. C. Mehta, *SIP*, p. 21.

¹³ There are three mosques at Jodhpur and one at Nagaur and one at Jalor in this style. It is characterized by several distinctive features like stone-lattices, etc. Vide Percy Brown, *Indian Architecture*, (The Islamic Period), Bombay, 1942, pp. 53; 56-57.

¹⁴ N. C. Mehta, *JGRS*, VII, 4, October, 1945, p. 139, f.n.

¹⁵ W. Norman Brown, *The Story of Kālaka*, Washington, 1933, p. 15, *

¹⁶ Ananda Coomaraswamy, *Rājput Painting*, Vol. I, Text, Oxford, 1916, pp. 1, 2, 5.

¹⁷ W. N. Brown, *The Story of Kālaka*, pp. 13-14.

Coomaraswamy too later on preferred the name 'Southern Rājasthānī' as the more appropriate designation.

It was Mr. N. C. Mehta who first maintained this art of miniature painting, as illustrated in the *Vasanta Vilāsa* paintings, which are completely akin to *Kalpasūtra* paintings, to be a distinctively Gujarati art.¹⁸ He pointed out that the *Vasanta Vilāsa* miniatures, though painted in a style commonly known as Jaina, had nothing to do with Jainism or with any distinctive traditions of Jaina aesthetics. As a matter of fact Jainism hardly showed anything like a distinctive art tradition though it generously patronised the arts, particularly the arts of painting and sculpture. Mr. Mehta pointed out that the characteristic features of the *Vasanta Vilāsa* paintings were derived from the folk-art tradition prevalent in Western India from the 11th century onwards.¹⁹ This tradition must have inspired murals too, as appears from the pictures painted on the stucco of the 15th century, forming a part of the interior decoration in the houses of this period, and exhibiting the same characteristics as the *Kalpasūtra* and *Vasanta Vilāsa* miniatures.²⁰

Mr. Mehta's stand was amply vindicated by the wealth of Vaiṣṇava and other illustrated Mss which have recently come to light. Among them are the illustrated Mss of *Gīta Govinda*, *Bālā Gopāla Stuti*, *Devīmāhātmya*, *Śrīmad Bhāgavata*, and *Rati Rahasya*, found and studied by Dr. M. R. Majumdar,²¹ and the very profusely and beautifully illustrated Ms of *Gīta Govinda* of the 16th century, acquired and discussed by Mr. N. C. Mehta.²²

There is another objection too against the view that attributes a Jaina origin to Gujarati pictorial art. Jainism is a religion of extreme austerity, which discountenances sensuousness in any form. It could not, therefore, have inspired paintings like *Vasanta Vilāsa* miniatures, which are entirely erotic and sensuous, some depicting even nude figures. It is only the art of architecture that has been influenced by Jainism

¹⁸ N. C. Mehta, *SIP*, 21-23.

¹⁹ *Ibid*, 21-23 ; *GPFC*, 25.

²⁰ N. C. Mehta, *GPFC*, 25.

²¹ M. R. Majumdar, 'A 15th century Gita Govinda Ms with Gujarati Paintings,' *Journal of the University of Bombay*, May, 1938.

" " 'Rare Sculptures from Koṭyarka and an illustrated Ms of Gita Govinda,' *Journal of the University of Bombay*, September, 1941.

" " 'Two Illustrated Mss of Rati Rahasya of the Gujarat School of Painting,' *Journal of the University of Bombay*, May, 1937.

" " 'Newly Discovered Durgāpāṭha Miniatures of the Gujarati School of Painting,' *New Indian Antiquary*, August, 1939.

" " 'Earliest Devī-Māhātmya Miniatures with special reference to Śakti worship in Gujarāt,' *Journal of the Indian Society of Oriental Art*, Vol. VI, 1938 (Gaganendranāth Tagore Memorial Number).

" " 'Illustrated Mss of Bilvamaṅgala's Bālā-Gopāla-Stuti,' *Journal of the University of Bombay*, September, 1947.

* Sarabhai M. Nawab, *Jaina Citra Kalpa Latā*, pictures, 57, 58.

²² N. C. Mehta, 'A New Document of Gujarati Painting—A Gujarati version of 'Gita Govinda,' *Journal of the Gujarat Research Society*, October, 1945 ; *Āchārya Dhruva Smāraka Grantha*, Pt. III, 1946, pp. 173-182 ; *Journal of the Indian Society of Oriental Art*, Vol. XIII, 1945.

to a certain extent, though there too the Jaina tradition does not show any marked divergence from the Brahmanical tradition. For, as Burgess has pointed out, the Jaina temples at Ābu and Bhadrēśvara belong to the same architectural tradition as the Brahmanical temples at Siddhapura, Somanātha and Ambaranātha.²³

The preponderance of Jaina material in Gujarati painting is explained by the fact that Jainism emphasised the copying and illustration of important texts as a part of its religious discipline. Thus Kumārapāla, the celebrated Solanki King of Gujarat, employed hundreds of scribes to copy the Jaina texts in ink of gold, and Vastupāla, the celebrated minister-savant spent seven crores of rupees in getting the Jaina works copied.²⁴ This activity reached its height in the 15th century when the Jaina teachers applied themselves whole-heartedly to building up vast *jñānabhaṇḍāras* of Jaina works, and the rich Jaina laity spent lavishly in getting the ancient texts like the *Kalpasūtra* and the *Kālakācāryakathā* illuminated and illustrated with the object solely of earning for themselves religious merit. Sangrāma Soni, a millionaire of Māṇḍavagarh (Mandu), 1436 A.D., is known to have spent 208,000 gold coins in having illuminated and illustrated copies of *Kalpasūtra* and *Kālaka Kathā*.²⁵ It is in this period, in the 15th century, that Somasundara Sūri, the well-known Jaina teacher, the hero of *Somasaubhāgya*, had hundreds of rare and valuable works written on palm-leaf transferred to paper,²⁶ and Jinabhadrasūri founded the famous Jaina *jñānabhaṇḍāras* of Pāṭan, Khambhāt (Cambay), Ahmedabad, Jesalmer, Jhālōr, Nāgor, Daulatābād and other places.²⁷ These *jñānabhaṇḍāras* have been jealously guarded by the Jaina community ever since.

On the other hand the Brahmanical centres of learning like Ānandapura (Vaṇnagar), Prabhās, Junāgaḍh, and Dvārakā suffered constantly on account of the Muslim raids, when their vast treasures of Brahmanical works were destroyed or irretrievably lost.²⁸ Hence not a single Brahmanical palm-leaf Ms has survived,²⁹ and even the classical works of poets like Narasimha and Mirā, who have won an immortal place in the hearts of the people, have failed to come down in any contemporary Ms. In these circumstances the Brahmanical material is necessarily scanty, while the Jaina material is quite abundant.

This fact has often been over-emphasised in determining the nature of this school of painting. It is certain that the art underlying the Brahmanical and the Jaina miniatures is essentially the same. There is absolutely nothing that could distinguish one from the other. The

²³ *The Antiquities of the Town of Dabhoi in Gujarat*, Jas. Burgess and H. Cousens, Edinburgh, 1888, pp. 1-2.

²⁴ Dr. Hirānanda Shāstrī, 'A Pre-Mughal Citrapaṭa from Gujarat', *Indian Historical Quarterly*, September, 1938, p. 425. Cf. also Sārābhāi Nawāb, 'Gujarātni Jaināsrita Citrakalā ane teno Itihāsa', *Jaina Citra Kalpadruma*, Introduction (Citrakalā Vibhāga), p. 46.

²⁵ N. C. Mehta, *GPFC*, 25 f.n.

²⁶ M. R. Majmudar, 'Two Illustrated Mss of Rati-Rahasya', *Journal of the University of Bombay*, May, 1937, p. 135.

²⁷ N. C. Mehta, *GPFC*, 25 f.n.

²⁸ M. R. Majmudar, 'Earliest Devi-Māhātmya Miniatures', *JISOA*, 1938, p. 126.

²⁹ M. R. Majmudar, 'Newly discovered Durgā-pāṭha Miniatures', *NIA*, August, 1939, p. 312.

artists who executed them were the same.³⁰ Very probably the artists were non-Jainas, who worked for patrons of every religion, otherwise they would not have fallen into the error of painting even Jaina *Tīrthankaras* with a Brahmanical *tripuṇḍra*, and decked with ornaments.³¹ It was a practice with the Jainas from very early times, and one which persists to this day, to employ Brahmins for teaching their Prakrit texts³² and for preparing copies of their sacred texts.

It will appear from the foregoing discussion that it is more appropriate to designate this art of miniature painting with reference to its geographical provenance than it will be to do so with reference to the creed of those who patronised it. The term 'Gujarati painting' introduced by Mr. Mehta has now been generally adopted by scholars.³³

One thing, however, deserves to be noted in using this term. The geographical boundaries of Gujarat in the Rajput period were different from what they are to-day. Gujarat then included a major part of Rajputana, and parts of Malwa and Khandesh. Gujarat in early mediaeval times was comprised of Northern Gujarat with Anahilpur Pāṭaṇ as its capital, and Southern Rājasthān with Śrīmāl or Bhinnamāla as the principal centre, while Lāṭa, the present Southern Gujarat, remained more or less a distinct unit. Culturally N. Gujarat and S. Rājasthān showed the closest affinities and formed one homogeneous cultural unit. Several of the higher castes of the present-day Gujarati community, such as the Śrīmālī Brahmins and Banias as also the Porvād Banias, have descended from Bhinnamāl or Śrīmāl in S. Rajputana. We have glimpses of such immigrations in works like the *Vilamalaprabhandha* of Lāvaṇyasaṃaya. The language current in this area—N. Gujarat and S. Rājasthān—during c. 1300—c. 1600 A.D. was the same, namely, Old Gujarati, or as some scholars would prefer to style it, Old Western Rājasthānī. It is very significant that several old Gujarati classics like the *Kāhnaḍade Prabandha* (1512 V.S.) were composed in and transmitted from the heart of Rājasthān.

In view of this cultural homogeneity prevailing in Gujarat and S. Rājasthān during this period it will not be a misnomer to designate the art of Gujarati miniatures from 1100 to 1600 A.D. as 'Early Rājasthānī,' or to be more precise, 'Early Southern Rājasthānī,' or simply as 'Early Western Indian' as suggested by Prof. Brown.³⁴ In fact after the 16th

³⁰ N. C. Mehta, *JGRS*, October, 1945, p. 139 ; M. R. Majmudar, *JUB*, May, 1938, p. 132.

³¹ Vide Sarabhai Nawab, *Jaina Citra Kalpalatā*, pp. 31 and 36, pictures 37 and 40 ; *Jaina Citra Kalpa Druma*, plates LJ and LXI.

³² Vide *Ibid*, pictures 21 and 26.

³³ Cf. A. K. Coomaraswamy, *Encyclopaedia Britannica*, 14th edition, Vol. 12, p. 217 ; also Vincent A. Smith, *A History of Fine Art in India and Ceylon*, 2nd edition, Oxford, 1930, p. 205. Note—Śrī Rai Kṛishna Dāsa in his *Bhāratiya Citrakalā* prefers a more comprehensive term like Apabhraṃśa school, which would include all local schools of painting in more or less the same style, prevalent all over India and even as far as Burma during this period. Though 90 per cent of the material in this style is Jaina, there is some non-Jaina material too revealing similar characteristics : the frescoes of Pagan, 12th century ; Tibetan (Buddhist) Palm-leaf MSS, 12th century ; Madanapāla temple paintings at Jhansi (U.P.), 11th century ; and the Avadhī Kāvya paintings, of the 14th century.

³⁴ W. Norman Brown, *The Story of Kālaka*, p. 14 ; also Foreword to *Jaina Citra Kalpa Latā*, ed. Sarabhai Nawab.

century the Gujarati art of Ms painting gradually merges into the Rājasthānī and Pahārī art. But as the term 'Rājasthānī' has already acquired a specific connotation by its association for a long time with Jaipur paintings of the 17th and 18th centuries executed in a style quite different from the Gujarati miniatures, it will lead to ambiguity and confusion to use it also with reference to the Gujarati painting.³⁶

III

Let us now review in outline the development of the Gujarati art of painting and discuss its characteristic features.

Gujarati art, as we have noted earlier, has had a long and glorious history. Gujarat possessed a distinguished art tradition even before the period of Ajanta and Elura frescoes, as appears from the references in Manimekhalai, Kathāsaritsāgara and the history of Tārānāth. Of this earlier phase of the Gujarati art we have no specimens surviving to-day.

The fresco-paintings of Ajanta and Elura represent the next phase of Gujarati art. As some art-critics have pointed out, it is possible to attribute the execution of these paintings to the Gujarati artists on historical and stylistic grounds. Western India had a great reputation as a centre of painting from ancient times, and all the surviving ancient specimens come from Southern and Western India. Some of the frescoes, like the Bagh, depict aspects of life which are distinctively and characteristically Gujarati. Stylistically there are several characteristics common to the fresco paintings of Ajanta and Elura and the Gujarati miniature paintings belonging to the period from the 12th to the 16th century. For instance the three-fourths profile with the further eye protruding from the facial outline, the long almond-shaped eye reaching to the ear, the pointed nose, the angular appearance of the face, which characterize the Gujarati miniatures, are found in the Elura and Ajanta frescoes.

Gujarati miniatures are derived from the earlier murals and continue the same tradition. They are like abridged versions of the earlier frescoes; if enlarged, they would look exactly like wall-paintings.³⁶ Gujarati miniatures constitute the last phase of Gujarati art before it became merged into the Rājasthānī art. It represents an intermediate stage between the earlier frescoes and the later Rājasthānī art.³⁷

The Gujarati paintings, however, cannot approach the aesthetic heights of the Ajanta frescoes. The Ajanta frescoes stand incomparable in their rhythmic composition, their extraordinary beauty of line, the majestic grace of their figures, and the wealth of their decorative imagery. The relative decline in Gujarati art from the aesthetic heights of the frescoes is due to the shifting of patronage. The frescoes at Ajanta and Elura were executed under royal patronage, while the Gujarati *Kalpasūtra* and other miniature paintings were rendered for the bourgeoisie, who

³⁵ N. C. Mehta, *JGRS*, October 1945, p. 129 f.n. 1.

³⁶ Coomaraswamy, *Rājput Painting*, Vol. 1, 3: Mehta, *SIP*, 17.

³⁷ N. C. Mehta, 'The Pictorial Motif in Ancient Indian Literature,' *JBORs*, Vol. XII, Pt. IV, 1926, p. 502.

could hardly be regarded to be the proper connoisseurs of art. Moreover, from early times there was a differentiation between the patronage art and the art attached to temple-building. The former developed into the *Kalpasūtra* and other miniatures, while the latter is revealed in the immortal frescoes of Ajantā, Bāgh, Elurā, Sigiriya and Sittanavāsai.³⁸ The former existed to please its patrons, the rich or the noblemen, while the latter drew its inspiration from religion and attempted to express through the medium of art ecstasies of religious fervour. The temple art soared high in artistic achievement, while the patronage art lagged behind.

The Gujarati art of miniature painting flourished during c. 1100 to 1600 A.D. So far it has only been found in the illustrated Mss of Jaina *Kalpasūtra* and *Kālakācārya Kathā*, Vaiṣṇava works like *Gīta Govinda*, *Bhāgavata*, *Bālagopālastuti*, Śākta *Devīmāhātmya*, and secular works like *Vasanta Vilāsa*, *Rati Rahasya* and *Kākanuta*. Of these a very limited number of Mss, mostly *Kalpasūtra* and *Kālakakathā*, are on palm-leaf, while the rest are on paper. Among the noteworthy illustrated palm-leaf Mss are the *Nisūthacūrṇi* Ms of V.S. 1157 in Sanghavi Pādāno Bhaṇḍāra, Pātaṇ;³⁹ the *Jñānasūtra* Ms of V.S. 1184⁴⁰ and the *Daśavaikālika Laghuvrtti* of V.S. 1200 in Shāntināth Bhaṇḍāra, Cambay;⁴¹ the Ms of 1218 V.S., containing the miniatures of goddesses reproduced by Mr. Nawab in *Jaina CitrakalpaDruma*;⁴² the *Kalpasūtra* Ms of 1294 V.S. referred to by Coomaraswamy;⁴³ and the palm-leaf Ms of V.S. 1427 in the Ujamfoi Grantha Bhaṇḍāra, Ahmedabad.⁴⁴ The palm-leaf period extends upto 1400 A.D., after which paper began to be used.

The surface offered for painting by the palm-leaf had ample length but very restricted width. Hence in the palm-leaf paintings the greater dimension is the horizontal, while in the paper paintings it is generally the vertical. The palm-leaf paintings are executed with wider stroke, are less complicated in composition and have fewer details than those of the paper period. The reason is that the palm-leaf is less adapted to fine and delicate work than is paper. Paper offers a much larger vertical dimension and is susceptible to finer workmanship. In paper paintings the broad and simple outline of the palm-leaf miniatures yield place to a more delicate drawing and elaborate composition with a multiplication of detail. The palette has also grown richer, gold, silver, blue and ochre being added to the palm-leaf tones. The miniatures of the paper period are thus more elegant, more sophisticated and more decorative than the earlier palm-leaf miniatures.⁴⁵

The style of the Gujarati miniatures is similar to that of the Ajanta frescoes, though it is not as accomplished as the latter. "The style is one of pure draughtsmanship; the colour is indeed brilliant but it is the outline that establishes the facts, and this outline, though exceedingly

³⁸ N. C. Mehta, *SIP*, 60.

³⁹ Sarabhai Nawab, *JCKL (Jaina Cika Kalpalatā)*, Introduction, p. 17.

⁴⁰ Brown, *The Story of Kālaka*, 15.

⁴¹ Nawab, *JCKL*, p. 2.

⁴² *Ibid*, pp. 2-3.

⁴³ Coomaraswamy, *HIA*, 120.

⁴⁴ Nawab, *JCKL*, p. 10, pictures 14-16.

⁴⁵ W. N. Brown, *The Story of Kālaka*, 20-22

facile and almost careless, is very accomplished, and very legible. In many cases the execution might well be called brilliant.... The variety of scenes and circumstances represented is very considerable, and the pictures afford valuable information on contemporary, or more probably, considering the conservatism of the style, earlier than 15th century manners, customs and costumes."⁴⁶ "The pictures are brilliant statements of the facts (of the narrative). There is no preoccupation with pattern, colour, or texture for their own sake; but these are achieved with inevitable assurance in a way that could not have been the case had they been directly sought. The drawing is in fact that perfect equilibrium of a mathematical equation, or a page of a composer's score."⁴⁷ "The figures are bound by bold and definite lines, and represent fundamental types and forms with no attempt at verisimilitude or elegance. The artist is more concerned with the narrative than with the exhibition of his accomplishment; and consequently the utmost possible use is made of symbols and suggestion, regardless of the harmonics of throbbing colour and balanced composition. *The colour scheme is extremely simple.... mere technical skill is always held in reserve, in complete subordination to the narrative flow of the pictures.... Shading, foreshortening, perspective, complexities of colour are conspicuous by their absence."⁴⁸ There is a naivety, an absence of self-consciousness in these pictures. They are generally idealistic, with the result that there is no proper portraiture in them. Their sole aim is to tell the story swiftly and vividly through the medium of line and colour.⁴⁹

This art has been criticised as not attaining its full aesthetic possibilities on account of its incomplete mastery of form and design, its lack of elegance, and its poverty of imagination, everything being pitched in a lower key. These limitations are attributed to its plebeian origin.⁵⁰ This criticism is a little too severe and perhaps underserved. It would be unfair to judge this early hieratic art by modern aesthetic standards. It has a different technique and a different purpose. It aims not at producing likenesses but at giving a pictorial representation of the narrative, and in this it has succeeded remarkably well.

Perspective in the usual sense is lacking in these miniatures. Depth, a characteristic feature of Western art, is absent in the Eastern art, as the standpoint of the latter is different and the comparatively small size of the productions does not require it. Eastern miniatures are like books to be read. The eastern artist sometimes makes use of what is called 'aerial perspective'; that is to say, the object portrayed is beheld by the artist from above, and not from a horizontal plane. This is admirably suited to his purpose, for it enables him to deal exhaustively with his theme within the limited frame of a single picture.⁵¹ Generally, however, he uses what may be called 'multiple perspective'—that is, the objects are observed not from one fixed point, but simultaneously from several points. He tries to differentiate planes, but does not correlate them.

⁴⁶ Coomaraswamy, *HIA*, 120.

⁴⁷ Coomaraswamy, *Jaina Paintings and Mss*, pp. 32-7, cited by N. C. Mehta, *SIP*, 18.

⁴⁸ N. C. Mehta, *SIP*, 17-18.

⁴⁹ M. R. Majumdar, 'An Illustrated Ms. of Gita Govinda' *JUB*, Sept. 1941, 129.

⁵⁰ N. C. Mehta, *GPFC*, 32-35.

⁵¹ N. C. Mehta, *SIP*, 33.

The anatomy of the figures in these paintings reveals several noteworthy characteristics. They are the three-quarter profile with the further eye protruding unnaturally beyond the facial outline, the almond-shaped eyes drawn out to the ears, the long pointed nose projecting beyond the outline of the cheek, the general angular appearance of the face, the exaggerated expansion of chest in the male figures, and the crossed-legs or the *bhadrāsana* posture.⁵² Sometimes, when representing deities like *Tīrthankaras* the full-front view is drawn, which appears quite inartistic. But the usual practice in the 14th and 15th century miniatures is to draw figures in three-fourths profile with the further eye bulging out in space. This typical treatment of the eye renders the expression of subtle moods and feelings impossible, with the result that the facial expression is always stereotyped. This deficiency is made up by the representation of rhythmic poses of the body (*abhinaya*), and appropriate movements of the hand (*mudrā*), in which the Gujarati artist excelled. The movements of the hands and fingers are most expressive, while the poses of limbs are exceedingly graceful. They express eloquently the moods and feelings, which could not, by the nature of the technique, be expressed in the faces of the figures.

The projection of the eyes in Gujarati miniatures has puzzled art-critics. Mr. Ajit Ghose explains it as due to the artist's desire to show that he was not painting something flat but trying to reproduce plastic figures.⁵³ Professor W. N. Brown attributed this practice to the imitation by painters of the Jaina Śvetāmbara images. In Śvetāmbara temples additional oval-like glass eyes are fixed upon the usual stone eyes of the images in order to give brilliance. They extend before the natural eyes of the image to the distance of half an inch or more. When viewed from an angle the further point protrudes into space beyond the line of the cheek like spectacles. This style of the temple-image was copied by the painter.⁵⁴

Professor Brown's explanation has to face some serious objections. This treatment of the eyes is not confined to the Jaina miniatures only; it is found in Vaiṣṇava and Śākta and secular Mss as well. It can be traced much earlier, to the period when the frescoes of Elura were executed, for the ceiling painting of Lakṣmī in the Kailāsa-temple, Elura, 8th century A. D., exhibits the same feature, viz. the bulging further eye.⁵⁵

Very probably the Gujarati characteristic is derived from these frescoes paintings. In the Elura frescoes the further eye projects, but the facial outline on the further side is still noticeable. It is a true three-quarter profile drawing. When the facial outline on the further side is omitted, and the pose remains the same, the result is the Gujarati technique. The Gujarati style should be considered a vestigial survival of the earlier fresco-tradition. The palm-leaf Mss of the Pāla school show a large part of the further cheek in the three-quarter profile, with the further

⁵² Coomaraswamy, *HIA*, 120; Brown, *The Story of Kālaka*, 16-18; cf. also the miniatures in Mehta, *GPFC*, plates; and Majmudar, 'A 15th Century Gīta Govinda Mṣ' *JUB*, May, 1938, plates; and Nawab, *Jaina Citra Kalpa Druma*, plates.

⁵³ Brown, *Ibid*, 16.

⁵⁴ Brown, *Ibid*, 16-17.

⁵⁵ Coomaraswamy, *HIA*, plate LVII, fig. 196.

eye bulging noticeably in some cases.⁵⁶ It appears that the Gujarati painting in Western India and the Pāla miniatures in Eastern India, both originated from the same technique of the Elura frescoes. The Pāla school approximates closely to the Elura technique, while Gujarati painting has advanced some stages further.

The Gujarati paintings throw a flood of light on contemporary customs, costumes, architecture and religion. We shall discuss here the contemporary costumes.

The dress scheme during this period appears to be simple, though the material used was very fine. Brilliantly coloured material with fine borders was favoured. It was printed in various patterns of stripes, spots, flowers and birds. The draperies were generally loose and untailored.

Men wore a dhoti, a short scarf thrown across the shoulders, leaving the upper part of the body bare, and a jewelled head-dress like a *mukūṭa*. They were very fond of ornaments and wore elaborate necklaces, star-shaped earrings, tight anklets, bracelets and *Kaḍās* on the arms. The hair was gathered in a knot behind, decked with lotus-buds and flowers.⁵⁷ They usually wore a short beard, which is not found in the frescoes of Ajanta and Bagh. Perhaps it was the survival of an old Indo-Iranian custom.

The male costume was very much akin to that in vogue during the period of Ajanta painting. The pyjamas and the turban were introduced later, after the advent of the Mughals, when they were adopted as their national dress by the aristocracy in N. India and Rajputana.⁵⁸ But the common man still continued to wear dhoti.

Women wore a long gaily coloured scarf broadest at the ends coming down from the shoulders and hanging loose below the knees. The lower portion of the body was wrapped in a different coloured waist-cloth, in appearance very much like a dhoti. Skirts seem to have been unknown. A tight-fitting bodice or *colī* covering the bust almost down to the waist and covering the arms upto the elbows was in vogue.⁵⁹ Women delighted to deck themselves with ornaments, bangles, necklaces of gold and jewels and garlands of flowers, *Kaṇaphoolā* or large circular earrings, head ornaments, *nūṇpurās* or anklets, and other ornaments. Nose-ring was unknown in this period, though sometimes women wore a diamond or a pearl as a nose-drop. The ancient girdle is absent.⁶⁰ They bear a round *kumkum* mark on their foreheads, as men bear the Vaiṣṇavite *tilaka*. Women of the aristocratic class wore *mukūṭas*, while those of the lower classes went bare-headed. The magnificent coiffures of Ajanta and Bagh have disappeared. Women wove their tresses in long and heavy plaits, sometimes attaching a tassel at the end.

⁵⁶ *Ibid*, pp. 114-115.

⁵⁷ N. C. Mehta, *GPFC*, 28.

⁵⁸ N. C. Mehta, *SIP*, 19.

⁵⁹ *Ibid.*, 20.

⁶⁰ *Ibid.*, 21.

The household furniture as revealed in these paintings seem to be rather limited—large and commodious bedsteads covered with dainty bed-spreads, raised seats, canopies, carpets covering the floors, and mounted heads of deer to serve as pegs. Swings, which are an outstanding feature of the modern Gujarati households, are met with rarely—only in the paintings of *Vasanta Vilāsa* and *Bālakrīḍākāvya*.

Landscapes are rarely depicted in these miniatures. Only one pure landscape exists in the *Vasanta Vilāsa* paintings.⁶¹ Clouds are represented by bold curves in blue, and horizon is shown as a blue wavy band at the top of the page. Rocks are painted as stumpy elevations sharply defined by irregular lines.⁶² Water is indicated by wavy lines, faintly bluish in colour, often shown with fish and lotuses inside it.

The treatment of trees is conventional but always charming. Against a dark background the heavy foliage is shown distinctly, each leaf being fully visible and arranged in a symmetrical pattern. Generally the trees are laden with blossoms. The trees are painted for purposes of decoration and for filling up the empty space on the two sides. Occasionally the trees are shown as bending inwards towards the figures, resulting in a typical symmetry. The trees generally represented are the graceful mango and the *bakula* trees, the stately palm, and the lovely pomegranate tree.

The animals too are shown in a conventional manner. The lion is rendered very much like the tiger. The representation of the horse, the elephant and the deer is, however, quite effective and vigorous. Of the birds, the crow and the parrot are often painted large in order to make them prominent. The peacock is drawn less frequently, but always with great care and considerable charm. A notable feature of these animal drawings is that the representations are generally doll-like and are usually decorative.

After the 16th century the Gujarati or Western Indian art gradually undergoes a change and merges almost imperceptibly into the Rājasthānī art of the 17th century. Of the paintings of *Vasanta Vilāsa*⁶³ and *Gīta Govinda*⁶⁴ those that depict love and the seasons develop later into the elaborately finished *rāgīnī* and *nāyikābheda* masterpieces of the Rajput school. Though there is some modification of technique in the latter, still their affinity with earlier miniatures can hardly be questioned.

This development was to some extent a result of the influence of the Mughal school. The influence of the Mughal art is noticeable in the Gujarati and Rājasthānī paintings of the 16th and subsequent centuries. The earlier technique has undergone far-reaching changes. The three-fourths profile has become a strict profile; floral patterns are frequently replaced by arabesques; the dress-scheme has altered, *angarkhās* and pyjamas in the male and skirts and *sāri* in the female attire coming into vogue. The primitive vigorous movements and significant poses and

⁶¹ N. C. Mehta, *SIP*, 27.

⁶² N. C. Mehta, *Ibid.*, 27.

⁶³ N. C. Mehta, *GPFC*, p. 30, pictures 57 and 64.

⁶⁴ M. R. Majumdar, 'An Illustrated Ms of Gīta Govinda,' *JUB*, Sept. 1941, p. 131, and plates VII, VIII and X.

gestures have given place to more delicate, refined and faithful representation of figures. The colour-scheme as also the general composition has become more complex and elaborate.

In spite of these changes the fundamental basis of the Gujarati and Rājasthānī art remains unaltered. Its inspiration has been mainly religion and folklore and its technique more or less idealistic.

The distinction between Rajput or Hindu and Mughal art, though clear enough, has, sometimes, not been adequately recognised. Mughal art is a complex of several elements. Its substratum is Rajput or Hindu, but it has changed, sometimes even beyond recognition, on account of Persian and sometimes Western influences. The Mughal school commenced under Akbar, when it was just an imitative art, copying the Iranian masters. It took great strides and gained considerably in dignity and prestige under the generous patronage of Jehangir, who showed more genuine interest and sounder judgment than his father. It cast off the servile imitation of Persian art, and ventured boldly into new regions. It was under Jehangir that the Mughal art found itself. It continued to flourish during the next two reigns, but at varying levels of excellence.

"Mughal art is at home in the portfolios of princely connoisseurs, but the Hindu paintings have stepped from the walls of shrines and palaces and public buildings, where their traces linger still. Mughal art is secular, intent upon the present moment and profoundly interested in individuality. It is not an idealization of life, but a refined and accomplished representation of a very magnificent phase of it. It is dramatic rather than static; young, fond of experiment, and ready to assimilate. It is splendid and attractive, but it rarely touches the deep springs of life. Its greatest successes are achieved in portraiture, and in the representation of courtly pomp and pageantry. All its themes are worldly. . . . The subject-matter of Mughal art, as such, is of purely aristocratic interest: while that of Rajput painters is universal. The distinction of Mughal from Rajput painting is indeed nowhere more apparent than in the fact that the former is aristocratic and professional, while the latter is at once hieratic and popular and often essentially mystic in its suggestion of the infinite significance of the most homely events. Mughal courtiers would not have been interested in an art about herdsmen and milkmaids, nor Vaishṇavas in pictures of elephant fights."⁶⁵ Mughal art subordinated mere technique or cleverness to sincerity of representation. This is in evidence not only in its portraiture, with its amazing characterization, but also in its very naturalistic and delicate treatment of trees and animals. Its extremely quiet and subdued tonality stands out in marked contrast to the intensely brilliant colouring of the Rajput art.⁶⁶

Mughal art must have influenced the Rājasthānī art, as we can judge from the change in the dress-scheme, ornamentation, pose, and colour-scheme, which came over the latter after the 16th century. Still

⁶⁵ Ananda Coomaraswamy, *Rajput Painting*, Vol. I, Text, Oxford, 1916, pp. 5-6.

⁶⁶ Coomaraswamy, *Encyclopaedia Britannica*, 14th ed., Vol. 12, p. 217; N. C. Mehta, *SIP*, 92.

“the Mughal art, however magnificent its brief achievement, was but an episode in the long history of Indian painting : Rajput painting, with the other Prakrit arts, belongs to the main stream.”⁶⁷ Mughal art could not outlast its period of court-patronage, while Rajput art continued to exist along with it and after it, witnessing a wonderful revival in the post-Mughal period under the patronage of accomplished Rajput Kings like Sawai Jaising.

IV

The central inspiration of the *Daśāvatāra Citra*, as of the entire Hindu art, is Vaiṣṇavism.

A tide of popular Vaiṣṇavism, swept through the entire country during the 15th and the 16th centuries, and dominated the religious and social life of the people up to the close of the 17th century. It brought about a cultural renaissance the like of which was never witnessed before, and inspired some of the finest poetry and painting, music and popular drama in the Northern and Western India during this period. It is responsible for the immortal Sanskrit classic *Gīta Govinda*, and the finest vernacular poetry of Narasimha in Gujarat, Mirā in Rājasthān, Suradāsa, Behāri, Matirām and Keśavadāsa in North India, and Vidyāpati, Umāpati and Candīdāsa in East India. In painting it has provided immortal themes to painters throughout these centuries.

In Gujarat Vaiṣṇavism in the form of Kṛṣṇa cult dates from very early times. The earliest evidence of the Kṛṣṇa cult in Western India is the sculptured pillar of 6th century A.D., illustrating two incidents from Kṛṣṇa's life, the Nāgadamaṇa and the Govardhanadhāraṇa, unearthed from Maṇḍor near Jodhpur by Dr. D. R. Bhandarkar.⁶⁸ A mediæval sculpture depicting Bālakṛṣṇa standing near the churning vessel is found on a pillar of the Modhera Sun Temple, 11th century A.D. An image of Govardhanadhārī Kṛṣṇa discovered at Devapattan and now in Verāval appears from its inscription to have been installed in V.S. 1302 by an Āhira lady. A stone inscription of King Śāraṅgadeva Vāghelā, V.S. 1348, reproduces as its benedictory stanza the last verse of the first canto of *Gīta Govinda*.⁶⁹ A variety of unique Viṣṇu images have been discovered in Gujarat, which by reason of their style or by specific inscriptions are recognised as belonging to this period. The celebrated *Dvyaśrayakāvya*, a historical epic of the Caulukya period, composed by Ācārya Hemacandrasūri, refers to a temple of the Daśāvatāra—the ten incarnations of Viṣṇu—situated on the banks of the Sahasraliṅga lake at Aṇahilpur Pāṭaṇ.^{69a} Bhavnagar Inscriptions

⁶⁷ Coomaraswamy, *Rajput Painting*, Vol. I, p. 6.

⁶⁸ Durgāshanker K. Shāstri, *Vaiṣṇava Dharmaṇa Saṁkṣipta Itihāsa* (Gujarati) 2nd ed., p. 148.

⁶⁹ viz. वेदानुद्धरते जगन्ति वहते भूगोलमुद्बिभ्रते । दैत्यान्दारयते बलिं छलयते
क्षत्रक्षयं कुर्वे [ते] ॥

[से] तुं बन्धयते हलिं कलयते काश्यपातन्वते । म्लेच्छान्मूर्च्छयते दशकृतिकृते
कृष्णाय [तुभ्यं न] मः ॥

Historical Inscriptions of Gujarat, ed. G.V. Acharya, Vol III, p. 89.

^{69a} *Dvyaśraya*, XV, 119.

mention a folio of the Ms of *Viṣṇubhakti Candrodāya*, dated V.S. 1469, which is evidently prior to the advent of Caitanya or Vallabha.⁷⁰

Thus the cult of Viṣṇu-Kṛṣṇa worship took roots in Gujarat in early times, much prior to the 15th century. It was, however, Vallabhācārya who turned it into a popular religion and made it a powerful dynamic force, influencing the social and cultural life of the people in a variety of ways.

V

Vaiṣṇava religion and mythology have ever remained the favourite theme of Hindu painters. Though paintings of other sects and setular themes are occasionally met with, Vaiṣṇava paintings predominate in the art of this period.

The most outstanding Vaiṣṇava work illustrated time and again is the *Bhāgavata*, the magnum opus of the Bhakti cult. Particularly the *Daśama Skandha* of the *Bhāgavata*, which describes Kṛṣṇa's romantic childhood, has been freely drawn upon by Hindu painters.

Several illustrated Mss of *Bhāgavata* have come to light so far. An excellent illuminated Ms of *Bhāgavata*, dated V.S. 1667, bearing an Old Gujarati legend, is preserved in the Jodhpur fort library.⁷¹ A stray folio of *Bhāgavata Daśama Skandha*, dated V. S. 1690, with a miniature in pure Gujarati style, was found in the Ms Collection of Śrī Vrajabhūṣaṇalālji Mahārāj of Kāṅkaroli near Nāthadvārā.⁷² An illustrated Old Gujarati Ms of Bhālaṇa's *Daśama Skandha*, painted in the 17th century when the Gujarati style was giving place to the Rājasthānī style, has come to light. There are some illustrated Mss of *Bhāgavata* in the Oriental Institute, Baroda. Mr. N. C. Mehta in his *Studies in Indian Painting* has reproduced two exquisite paintings of 'Rāsamaṇḍala' and 'Govardhanadhāraṇa' by an unknown artist of the Jaipur school, and some charming paintings of Kṛṣṇa's childhood by Mānaku and Chaitu of the Tehri-Garhwal School. Dr. Coomaraswamy has published in his *Rājput Painting* (Vol. II) several beautiful paintings of Kāṅgrā school depicting scenes from Kṛṣṇa's early life. Numerous other *Bhāgavata* paintings of different schools are also known to exist.

Gīta Govinda, which in Vaiṣṇava religion ranks only next to *Bhāgavata*, is the finest expression of Vaiṣṇavism in poetry. Its music is exquisite, and its poetry supremely beautiful. But it is the religious aspect of this great Vaiṣṇava classic that has appealed most to the popular mind. *Gīta Govinda* soon became a part of Vaiṣṇava religious lore, and Jayadeva began to be reckoned among the greatest *bhaktas* who were the Lord's elect.⁷³

⁷⁰ *Prakrit and Sanskrit Inscriptions*, pub. Bhavnagar Archaeological Department, p. 161.

⁷¹ M. R. Majmudar, 'Some Illustrated Mss of the Gujarati School of Painting,' *Proceedings of the Seventh All-India Oriental Conference*, 1933, pp. 827-837.

⁷² M. R. Majmudar, *JUB*, Sept. 1941, p. 131.

⁷³ Cf. *Surata Sangrāma* of Narasimha Mehtā, pada 23-26. Vide *Narasimha Mehtā Kṛta Kāvya Saṁgraha*, ed. Icchārām Sūryaram Desai, 1913, pp. 101-102.

Gīta Govinda with its colourful romances of Kṛṣṇa and its sublime conception of the ten incarnations soon became a favourite of painters, who delighted to depict in colour its varied scenes. Several illustrated Mss of *Gīta Govinda* have come to light so far, and been studied.

The earliest one belongs to the middle of the 15th century. It is in the Gujarati style, the miniatures being stylistically identical with those of *Kalpasūtra*, *Vasanta Vilāsa* and *Bālakṛṣṇakṛīḍākāvya*. It paints Śārādā and the following six incarnations—Matsya, Kacchapa, Varāha, Nṛsiṃha, Vāmana and Paraśurāma. Other avatāras are not traceable, perhaps because the Ms is incomplete. Hence there is no colophon also. On stylistic and calligraphical grounds it seems probable that the miniatures belong to the middle of the 15th century.⁷⁴

The next illustrated Ms of the *Gīta Govinda* is the one in the Gujarat Vernacular Society's collection, published by Professor M. R. Majmudar in *JUB*, September 1941. It belongs approximately to the early 16th century and is in Gujarati or early Rājasthānī style. The Ms is incomplete, ending abruptly at the end of the 11th *sarga*. Hence the name of the copyist or the artist remains unknown. But the primitive nature of the design and the simplicity of composition suggests an early date.⁷⁵ Like Coomaraswamy's 'Kṛṣṇa expecting Rādhā'⁷⁶ it might belong to the late 15th or early 16th century. The dress-scheme is in continuation of the pure Gujarati style, which starts slowly assimilating the Rājasthānī elements. There are introductory remarks in Old Gujarati at the bottom of the first folio, which establish the Gujarati origin of the paintings. There are 35 miniatures and 34 folios in the Ms. They contain only one of the incarnations, namely that of Vāmana, the rest of the miniatures depicting Kṛṣṇa with Rādhā or Gopīs in various situations. They do not reveal any great technical excellence, and Kṛṣṇa's figure is very poorly drawn, being neither expressive nor elegant.

The third Ms in sequence of *Gīta Govinda* is the one acquired by Mr. N. C. Mehta, and published by him in *JGRS*, October 1945, *Ācārya Anandashanker Dhruva Smāraka Grantha*, Part III, 1946, and the *Journal of the Indian Society of Oriental Art*, Calcutta, 1945.⁷⁷ It is the most profusely and elaborately illustrated document of Gujarati painting and is interesting in a variety of ways. The figures are more alive and the technique older and more akin to that of the fresco-paintings than several other known examples of Gujarati painting. The Ms belongs probably to the close of the 16th century. The miniatures are certainly very elegant and dainty as appears from the black and white reproductions in the *JGRS*, and the coloured plates in the *Anandashanker Smāraka Grantha*, and the *JISOA*.

Mr. N. C. Mehta has also noted some stray pages of *Gīta Govinda* done in the Mughal style perhaps during the time of Akbar, in the collection of Sir Cowasji Jehangir.⁷⁸

⁷⁴ M. R. Majmudar, 'A 15th Century Gīta Govinda Ms with Gujarati Paintings,' *JUB*, May 1938.

⁷⁵ M. R. Majmudar, 'An Illustrated Ms of Gīta Govinda,' *JUB*, Sept. 1941, p. 125.

⁷⁶ Cf. Coomaraswamy, *HIIA*, pl. LXXXII, fig. 258.

⁷⁷ N. C. Mehta, 'A new Document of Gujarati Painting—A Gujarati version of Gīta Govinda.'

⁷⁸ N. C. Mehta, *Ibid.*, *JGRS*, 141.

A very remarkable version of the *Gīta Govinda* is the one painted in the Basholi style by Manaku, a talented woman painter, in 1730 A.D. The pictures are very charming and the verse is illuminated in gold.⁷⁹

Dr. A. K. Coomaraswamy has published two pictures of *Gīta Govinda*, entitled सामोददामोदरः⁸⁰ and नागरनारायणः⁸¹ executed in the Pahāri (Early Kāngrā) style of the early 18th century. The former depicts Kṛṣṇa dallying with the Gopīs. In the latter Kṛṣṇa's costume resembling a Rājput nobleman attracts attention. The treatment of the landscape is realistic in both.

The most magnificent version of *Gīta Govinda* comes from Māṇaku, the court-artist of Tehri-Garhwal, in the first half of the 19th century. It is in the possession of the Tehri Durbar. Some of these paintings are reproduced in Mr. N. C. Mehta's *Studies in Indian Painting*. Māṇaku's landscape painting shows great charm and beauty and his colour-schemes are very sumptuous. He excels in painting night-scenes with sharp contrasts of light and shade.⁸²

There are several other versions of *Gīta Govinda*, executed in the later and highly ornate Rājasthānī style.⁸³ A brilliant series of *Gīta Govinda* pictures, executed by a local school of artists at Kishengarh near Jaipur, has recently been discovered. Some of them are dated 1840 A.D.⁸⁴ Dr. Stella Kramrisch has published the illuminations of *Gīta Govinda* Mss, about a century old, from Bengal, in the *Journal of the Indian Society of Oriental Art*, December, 1934.⁸⁵

Of the various scenes in *Gīta Govinda* the most frequently illustrated are the *Daśāvatāra* or the Ten Incarnations of Kṛṣṇa. Most of the illustrated Mss of *Gīta Govinda* depict several or all of the incarnations, sometimes to the total exclusion of other themes. It appears that the introductory *Daśāvatāra* of *Gīta Govinda* had cast a spell on popular imagination. It was invoked in the royal inscriptions⁸⁶ and represented on the palace⁸⁷ and temple walls. The mediaeval Gujarati poetry contains many allusions to the painting of the *Daśāvatāra*. Premānanda, for instance, refers to the tradition of painting mythological scenes in his poetical romances—*Okhāharaṇa*⁸⁸ and *Rukmiṇīharaṇa*. In the latter he describes how painters drew the ten incarnations, the childhood of Kṛṣṇa, and various mythological episodes with remarkable vividness

⁷⁹ N. C. Mehta, *Ibid.*, 141. Note—There are some remarkable illustrations of *Gīta Govinda* of the most accomplished period of Basohli art in Mr. Ajit Ghose's collection. One of them is reproduced in *Rūpam*, No. 37, Jan. 1929, p. 6.

⁸⁰ Coomaraswamy, *Rajput Painting*, Vol. II, pl. XXXVIII.

⁸¹ *Ibid.*, pl. XXXIX.

⁸² Vide N. C. Mehta, *SIP*, p. 56, pl. 24.

⁸³ The Central Museum, Lahore, possesses a very large collection of illustrations from *Gīta Govinda*. Vide *Rūpam*, No. 37, p. 15 f.n.

⁸⁴ N. C. Mehta, *JGRS*, Oct. 1945, 141.

⁸⁵ Stella Kramrisch, 'An Illustrated *Gīta Govinda* Ms,' *Journal of the Indian Society of Oriental Art*, Vol. II, No. 2, Dec. 1934, pp. 115-126.

⁸⁶ Cf. Sāraṅgadeva's inscription of V. S. 1348.

⁸⁷ The murals in the Padmanābhapuram palace in the Travancore State illustrate the ten *avatāras*. Cf. N. C. Mehta, *JGRS*, Oct. 1945, p. 142.

⁸⁸ *Okhāharaṇa*, *Kadavā* 19; *Bṛhatkāvyadōhana*, 7th edn., p. 55.

and effect.⁸⁹ The *Dasāvatāra* thus seems to have been a very popular theme for mural and miniature painting in mediaeval Gujarat.

VI

The present *Dasāvatāra Cītra* is an album, or a picture portfolio.⁹⁰ I came across it in Pāṭaṇ in North Gujarat during one of my tours in search of Old Gujarati Mss, and it was made available to me for study through the courtesy of Śrī Rāmlāl Chuniāl Modi, the well-known scholar and antiquarian. It is the first complete series of *Dasāvatāra* miniatures known so far. It is also singularly interesting as a specimen of Gujarati painting in its transitional stage from the pure Gujarati style to the Rājasthānī.

The pictures originally must have been in a *pothi* form, the ten pictures comprising as many folios of a Ms. Later they were pasted on brown paper pages, one on each side, with gum, perhaps by its last collector. In order to see if there was any inscription on the reverse side of the paintings I separated the first and the last folios from the brown paper on which they were pasted. Neither of the folios were found to bear any colophon indicating the painter's name⁹¹ or the date. The first page revealed only three lines which I could not properly comprehend.⁹²

Some one, perhaps a reader or owner of the album, has written in a slipshod manner in crude Devanāgarī characters the names of the figures painted and some lines from some Old Western Rājasthānī text. Most of these citations are on the topmost part of the folio, which has worn out on account of imperfect preservation. I could not, therefore, read any of them except the lower legend in the *Vāmanāvatāra* painting. It is, therefore, difficult to say whether the album formed a part of some illustrated version of a work like *Gīta Govinda* or *Dasāvatāra Stotra* in Old Gujarati or Old Rājasthānī. Very probably the paintings are a set by themselves unrelated to any text.

For the probable date of the paintings the internal evidence is our only source of information. From the general condition of the Ms it is, I think, safe to assume that the album belongs to the 17th century. This view is confirmed by Mr. N. C. Mehta on sartorial grounds. The costumes of the figures in this album closely correspond to the typical costume of the Shahjehan period. The pictures are definitely more primitive in style than the later Rajput paintings, and more elaborate and complex than the Gujarati miniatures of the 15th and the 16th centuries.

⁸⁹ Cf. त्यां तो सुर असुर सायर मथ्या, काव्या दशे अवतार. *Rukminītharāṇa, of Premānand, Kadavū 4, Prācīna Kāvya Mālā* No. 14, ed. Hargovinddās Kāntāvālā and Nāthāshanker Shastri, Baroda, 1890-91, p. 109.

⁹⁰ The practice of preparing picture albums dates from very early times. Cf. *Kathāsarit Sāgara*, XVIII, 3, vss 20-24.

⁹¹ This is in conformity with the general tradition of the Hindu art, which is always anonymous and conservative. Cf. Coomaraswamy, *Rajput Painting*, Vol. I, p. 6.

⁹² The lines read— शशी बीश्वानर आपूरम् त्रय्ये क्षीण न ग्यन्त ।

जो जीवन्ता उगरे तो ककर उडे करंत ॥

The question whether the style should be called Gujarati or Rājasthānī is not easy to decide. The Rajput head-dress appears to favour Rājasthānī origin, while the find-spot of the album and the Old Gujarati inscription in the picture of the Vāmanāvatāra points to a Gujarati origin. The head-dress too is not exclusively Rajput; Vāmanā's headgear closely corresponds to the typical Kāthiāwārī *pagari*. The diaphanous *angarkhā*, which was the standard dress of the Rajput and Mughal aristocracy, figures occasionally in the *Daśāvatāra Citra*, while it occurs regularly in the Gujarati paintings of *Gīta Govinda* of the 16th century, published by Mr. N. C. Mehta. The female drapery in *Daśāvatāra* appears to be somewhat akin to the Mārvādi; but similar female dress-scheme is met with in Gujarati paintings of this period. These Rājasthānī elements are a consequence of the very close cultural and political affinities between Gujarat and Rājasthān during the entire mediaeval period and later. Some of the typically Gujarati miniatures happen to be painted, and some of the classical *rāsas* of Old Gujarati literature were composed, in the heart of Rājasthān. The Gujarati style starts assimilating Rājasthānī elements after the 16th century and gradually and imperceptibly merges into the latter. The present album does not reveal any pronouncedly Rājasthānī traits nor does it show very noticeable Mughal influence except in the representation of trees. It is, as we have noted, rather primitive in style compared to the Rājput paintings. We are, therefore, justified in considering the *Daśāvatāra* paintings as Gujarati.

The present *Daśāvatāra* album consists of ten miniatures, each illustrating one incarnation of Viṣṇu. The order of the incarnations is Matsya, Kacchapa, Varāha, Nṛsiṃha, Vāmana, Paraśurāma, Rāma, Kṛṣṇa, Buddha and Kalki. The miniatures measure 8.3" to 8.6" in length and 4.4" to 4.6" in breadth. The average length and breadth is 8.4" and 4.4". The state of preservation is bad enough just like numerous other Brahmanical illustrated Mss, which can never compare with Jaina Mss in the matter of preservation. Some of the paintings have suffered, sometimes lamentably, especially in respect of the colouring. Still they are more remarkable and aesthetically superior to several of the Brahmanical miniatures published so far.

The paper used is handmade Indian paper, rough in surface and brownish in colour. Each panel is enclosed in two small marginal boundaries, the outer one being red and the inner one yellowish, or perhaps brownish-yellowish, matching the original colour of the paper. Within this double frame the picture is set. As the paper used lacked the necessary thickness to withstand the wear and tear of time, another paper, plain and precisely of the same size, has been pasted to each painting on the reverse side.

The colours used are indigenous, and some of them have preserved their original freshness even after the lapse of three centuries. There is no legend written by the copyist to guide the painter. The names of the principal figures are written by some one in a crude hand in black ink. It could not have been the original painter who would have done it carefully without disfiguring the pictures. It was evidently some later reader or owner without much education, as his defective spellings and lack of aesthetic sense suggest.

The technique of Hindu paintings has remained practically unchanged from the time of the Ajanta frescoes to the Rajput miniatures. Like all the Gujarati and early Rājasthānī paintings the present miniatures too are primarily an art of outline. It appears that first an outline was drawn freely in red with a brush on the burnished surface of the paper. Over that a white priming was spread, which appears in all pictures at the top as the boundary of the horizon. Then a second outline, more highly finished, is drawn over the first, in black, sometimes modifying the first outline. This second outline is executed with meticulous care and establishes all the facts intended for representation. Then the background is coloured and then the figures. On the figures are painted the usual ornaments, weapons, etc., in appropriate colours. Lines in golden colour to indicate gold ornaments and brocade appear to be drawn last. If the outline is blurred anywhere during the process it is redrawn, and the painting is finally complete.

The art of these miniatures is essentially one of draughtsmanship. It is not a specimen of the classical art, but a product of the folk-art, fused with Vaiṣṇava hieratic tradition. We come across survivals of this type in the 18th century Rājasthānī paintings like the 'Gajendra-mokṣa' painting reproduced by Coomaraswamy.⁹³

The drawing in the *Daśāvatāra* pictures is rather linear but bold and meticulously precise, the outline establishing all the details of the narrative. The artist works out all the details of the incidents with scrupulous care. Though there is considerable technical skill, there is, as in all folk-art, an air of simplicity, a naïveté in these pictures. As in all Gujarati art the emphasis is on the illustration of the incidents rather than on the representation of actual appearances. Still within these limitations imposed upon him by the tradition the artist has been able to achieve some remarkably expressive figures. It is the result of his profound knowledge of natural and significant gestures and his skill in rendering them with vigour, and effect. This amply compensates for his traditional formalism and lends a distinct charm to the paintings.

The treatment is adequate and confident. The outline is very delicate and precise, the representation of figures and scenes is more naturalistic than the primitive Gujarati miniatures, the ornamentation is often more sumptuous and the colouring more elaborate than in the earlier art. At places the portraiture is quite expressive, the various moods and feelings of the figures being effectively shown on their faces. The arrangement of the figures too is quite skilful. Perspective or depth, which entered Hindu art as a result of the influence of Mughal art, is conspicuous by its absence in these pictures. It makes the paintings look rather flat. The draughtsmanship, however, is singularly clever, and the colour harmony is remarkable.

The colour-scheme of these paintings is warm and attractive. There is, as in all folk-art, a partiality for gay colours, and the general tonality is quite sumptuous. There is a preponderance of red and yellow. The other tones are white, blue and occasionally green.

⁹³ *Rajput Painting*, Vol. II, pl. XVI.

Red or more precisely brick-red and yellow and occasionally blue are used for the background. Out of the ten miniatures no less than four have a brick-red background, which establishes the antiquity and affinity of these paintings to the Gujarati school, while two have a light yellow background. The rest have each a different background—blue, grey, violet, green, and bluish green. Against these backgrounds, light and sombre, stand out in sharp relief the figures of the *dramatis personae*. Viṣṇu's incarnations are painted invariably in blue while the rest of the figures are drawn in a mixture of white, pink and yellow in various shades. The male apparel is white, orange or yellow, while the female apparel is generally red or yellow. Green is used generally in the depiction of the trees, though on two occasions the *pagari* of the attendants is also painted green. Water is shown in bluish black tint. Black is used in the figures of Śeṣanāga and for the steel weapons. Ornaments and accessories are shown in appropriate colours. Faint gold colour surviving at certain places indicates the golden ornaments worn by the *dramatis personae*.

As in the Gujarati paintings after the 16th century the figures are generally shown in strict profile. Only on three occasions—in the painting of Brahmā, Rāvaṇa and Buddha—the full frontal view is painted. In the first two the multiplicity of the heads had compelled the frontal treatment, while in painting Buddha's figure the artist has merely imitated the iconographical tradition. In all the three cases the treatment appears flat and inartistic. In the case of the rest of the figures the movements and gestures have been rendered with considerable effect. In some cases the artist has successfully achieved the expression of moods and sentiments, particularly the Heroic (*Vīra*) and the Marvellous (*Adbhuta*).

Unlike the primitive Gujarati painting animals are depicted realistically in these miniatures. The figure of Śeṣanāga is drawn with meticulous care and delicacy. The horses of Rāma's and the donkeys of Rāvaṇa's chariot are drawn realistically. The horse in the last incarnation, Kalki, is a fine specimen of animal drawing. It is perhaps the most remarkable animal drawing in this album. The figure of a jumping monkey, perhaps Hanumān, in the Rāmāvatāra miniature shows singular grace of movement and considerable vigour. There are no birds shown in these paintings. A mammoth fish is painted in the Matsyāvatāra, but the tortoise in the Kacchapāvatāra is somewhat conventional. In the portrayal of animals the present paintings mark a distinct advance over the conventional painting of the earlier Gujarati art.

The depiction of trees and plants is very realistic and quite delicate and charming. The more generally represented trees are the plantain and the mango-tree. A tree with large roundish deep green leaves is painted twice. It might perhaps be the *pippala* tree. A stately palm is shown in the last picture. The treatment of trees is far more realistic and natural than in the earlier phase of the Gujarati art as a result, perhaps, of the Mughal influence. In these compositions trees generally come in to fill the blank space on two sides, right and left, and also incidentally serve as an ornamentation. The foliage is shown in a typical fashion—all leaves appearing distinctly in a charming symmetrical pattern, the intervening spaces painted in indigo blue serving as a back-

ground. Though in the earlier Gujarati art we come across the representation of foliage against a coloured background, the practice of showing naturalistic foliage on an indigo blue ground is a typically Mughal characteristic. Smaller flowers are usually painted in white or yellow, starshaped, while lotuses are shown more prominently, with white petals and pinkish borders.

Pure landscape painting is very rare in Gujarati art. Landscape, however, is often painted as a background or setting to the scenes illustrated. Water, *i.e.* sea or river, is shown in the foreground, by wavy lines in deep blue, with whitish curved lines marking the crest of the waves. The representation is quite charming, though it is somewhat conventional. The same technique prevails in the Rājasthānī paintings of the 17th and 18th centuries. An irregularly running light blue strip about $\frac{1}{2}$ " to $\frac{3}{4}$ " in breadth, at the top shows the sky. It commences with a thick white line separating it from the background. That is, evidently, the horizon. As the extremities have worn out, the clouds, if any, cannot be distinguished in the present state of the paintings. No ponds are shown in these miniatures nor are there any rocks.

The costumes are very interesting as representing a stage intermediate between the pure Gujarati and the later Rājasthānī style.

Of the male figures gods and Brahmins are generally painted as wearing a short dhoti, or more accurately a *pītāmbara*, a little below the knees. It is usually red or yellow in colour, and is very probably silken. Only one the figures, Vāmana, wears a white dhoti. The dhoti or *pītāmbara* is held at waist by a waist-band, generally of gold. The Kṣatriya Kings and attendants are shown as wearing a different costume—the *angarkhā* and the pyjamas. The gods and the Brahmins have a scarf, usually white and occasionally red or yellow, with a tiny red fringe, thrown across their shoulders. The flowing scarf lends a distinct grace and dignity to the figures. The Kṣatriyas have a similar scarf, mostly of coloured material, tied round their waists as a *kamarabandh*, just like the present-day Rajputs in Rājasthān and Girāssiās in Kāthiāwār. Gods and Kings wear golden crowns, while the ordinary attendants are wearing Rajput turbans. Brahmins generally go bare-headed. They wear long hair, gathered up in a top-knot, which is adorned by a flower. Some of the principal male figures wear shoes very much like the *deśi* shoes of to-day.

The female dress-schemes closely resembles the dress of the modern Gujarati women. In these miniatures women are shown as wearing coloured, usually yellow or blue, skirts, and over them coloured *sāris* of diaphanous material. The bust is covered by a tight-fitting bodice or *coli* of blue, yellow or green material. The women evince a partiality for red or yellow draperies. They are not shown as wearing shoes or similar footwear.

Both men and women display a great liking for ornaments. Women have their arms almost loaded with ivory *cuḍis* and golden *kangans*. Dark decorative hangings of silk, appearing very much like *mindhalas*, are attached to the ornaments on the wrists and the arms. They are known as *makhtūla* in Hindi. Round the neck they wear gold

chains, gold and diamond or pearl necklaces, and *hānsaḍis*.⁹⁴ Several ornaments adorn their heads. A jewelled ornament is seen just above the forehead dropping from the parting line of the hair. Could it be the mediaeval prototype of the modern *bora*? A jewelled *dāmaṇī*, or *bandibenā* as it is known in Hindi, is suspended from the sides of the head practically marking the curve of the plaits of hair just above the ear. Large circular pearl or jewel earrings adorn the ears. Some nose-ornament like a gold or diamond *cuni* is worn on the left side of the nose. Women weave their plaits in a loose braid falling on the back from which some ornament appears to dangle. It is perhaps only a tassel. It is difficult to decipher if the women wear any girdle. Most probably they do not. On the ankles are worn *jhānjharī* or anklets, petal-shaped, possibly of gold as appears from the surviving traces of golden colour. The mode of drawing the *sārī*-fringe in a veil (*ghunghaṭa*) is noteworthy.

Men also betray an equal fondness for ornaments. Gold and pearl or diamond necklaces for the neck, diamonds on the crest of the crown, pearl or diamond earrings on the ears, and gold *kaḍās* or *valayas* on the hands are the usual ornaments worn by men. They also appear to be wearing a waist-band, most probably of gold, which however cannot be quite clearly distinguished. The bare-headed male figures appear to have adorned their top-knots with flowers.

Three of the male figures wear a short beard. It is a feature persistently noticed in the Gujarati paintings from the 12th to the 16th century.

Both male and female figures bear the Hindu mark of piety, *tilaka* of *kumkum* or of sandalwood paste. None of the figures, not even Buddha's image, bears any halo round its head.

The incidents painted do not permit the depiction of much furniture, etc. In some paintings, however, are found raised seats (*pāṭa*), sumptuous bed-steads covered with gaily coloured bed-spreads, round *takiyās* or cushions, gorgeous royal thrones, attractive canopies, flowing chowries, and lovely silk umbrellas. No swings are met with. The front hall of the house is shown in elevation. Shapely arched pillars, delicate eaves, projecting balconies, latticed windows, decorative niches and parapets are also noticeable.

In this way these paintings provide us with a volume of information on several interesting aspects of contemporary life and manners.

VII

Let us now comment on the individual pictures of the present *Daśāvatara Citra*, establishing comparisons with similar paintings known so far. We shall have occasion to refer incidentally to *ava'āra-praśastis*—descriptions of Viṣṇu's (or Hari's) incarnations⁹⁵ in charming verse—

⁹⁴ A thick round neck-ornament made of twisted gold wires.

⁹⁵ cf. वेदानुद्धरते of Jayadeva. Supra f.n. 69 ; also

पाठीनः कमठः किटिर्नरहरिः खर्षाकृतिर्भार्गवो

रामः कंसनिषूदनो दशवल्गुः कल्की च नारायणः । ,

युष्माकं स विभूतयेऽस्तु भगवान्सेतुर्भवाभोनिधा-

वुत्ताराय युगे युगे युगपतिर्लोक्यनाथो हरिः ॥ —*Śārngadharapaddhati*, 133.

which are such favourite themes of Sanskrit poets. We do not come across similar *Dasāvatāra stutis* in mediæval Gujarati literature. The verse inscribed in the Vāmanāvatāra painting closely corresponds to a verse in Premānand's *Vāmanacaritra*, but cannot be definitely traced to any known work.

The present *Dasāvatāra Citra* has no dedicatory picture like that of Śārādā in the 15th century *Gīta Govinda* Ms published by Majmudar.⁹⁶ The present album commences forthwith with Mātsyāvatāra. The incarnation is represented by the figure of Viṣṇu emerging from the mouth of a mammoth fish in the sea.⁹⁷ The blue form of the god stands out clearly against the brick-red background. The god wears a red *pīlāmbara*, a yellow scarf across the shoulders, and a golden crown on the head. In the upper right hand he holds a golden mace, and in the upper left a conch. In the lower two hands he has Mss. He wears a diamond or pearl necklace and *kundalas*. His figure is delicately drawn and expressive. His face is turned towards Brahmā on his left.

Brahmā is sitting on a colossal lotus. He is wearing a yellow dhoti or *pīlāmbara*; the upper part is bare like Viṣṇu's. Brahmā has four heads, two facing Matsya and the other two on the opposite side. All the four heads have short beards. His upper right hand is in a *pravacanamudrā*, and the lower holds a white rosary of pearls. The two left hands are empty, perhaps because the Vedas they held were swept away in the Deluge. They are retrieved by the Matsya god, who is shown as offering the Mss to Brahmā.

We are pointedly reminded of the Rājasthānī painting of early 17th century entitled 'Khambāvatī Rāgini', representing the figure of Brahmā.⁹⁸ There Brahmā is shown seated, four-headed and four-armed, holding the Vedas, a rosary, and a spoon to feed the sacrificial fire with *ghee*. He is wearing an *angarkhā*, a necklace, and triangular *mukutas*. A woman is shown as worshipping the god.

In the present album Śankhāsura is shown as a half-figure, issuing from a huge conch, holding a mace, with a lion's face and human body. He is lying flat, face downwards, on the bed of the sea, quite dead as shown by the profuse marks of blood on his prostrate body.

Up in the sky are shown two gods in an aerial car resembling a small boat, scattering flowers over the Matsya incarnation. Their heads are not seen as the upper extremity of the panel has worn out. A similar representation of gods in an aerial car worshipping Viṣṇu is met with in the classical painting of 'Gajendramokṣa,' of the Rājasthānī school, of the 18th century.⁹⁹

⁹⁶ JUB, May 1938, pl. IV.

⁹⁷ cf. दिश्याद् वः शकुलकृतिः स भगवान्भैःश्रेयसी संपदं
यस्य स्फूर्जदतुच्छपुच्छशिखरप्रेङ्खोलनक्रीडनैः ।

विश्ववार्धिसमुच्छलजलभरैर्मन्दाकिनीसंगतैः

गङ्गासागरसंगमप्रणयिनी जाता विहायःस्थली ॥ —Śaṅgadharaṇapaddhati, 123 ;

also cf. Śaṅgadharaṇapaddhati, 81-82; Saduktikarṇāmṛta I, 37.

⁹⁸ Vide Coomaraswamy, *Rajput Painting*, Vol. II, plate VI,

⁹⁹ Vide Coomaraswamy, *Ibid.*, plate XVI,

The representation of water in the *Daśāvatāra Citra* with lotuses rising up is quite graceful, though somewhat conventional, and reminds us of the 17th century Rājasthānī paintings of 'Asāvarī Rāgīnī' and the 18th century Early Kangra pictures of 'Kāliyadamana' and 'Cīraharaṇa'¹⁰⁰ where water is shown in a similar style.

The picture of Matsyāvatāra in Majmudar's set of *Gīta Govinda* miniatures of the 15th century represents a single huge fish seated on a circular seat with two small fishes near by for contrast. A woman painted in typical Gujarati style stands on the left of the incarnation.¹⁰¹ The present *Daśāvatāra Citra* treats the subject more realistically and in far greater detail. The figure of the Matsya god offering the Vedas to Brahmā, the stately figure of Brahmā sitting on a thousand-petalled lotus are very delicately drawn and full of charm.

The second picture depicts the Kūrmāvatāra—the tortoise incarnation.¹⁰² In the foreground is shown water, with pink petalled white lilies rising above. In the centre of the water is shown the figure of a green tortoise, with an unusually wide mouth from which emerges the figure of Viṣṇu. It is precisely like the figure of Viṣṇu in the Matsyāvatāra ; only the attributes are different. In the upper right hand of the Kūrma God is a lotus, and in the lower right hand a conch. The upper left hand holds a discus (*cakra*), and the lower a mace. The figure is in profile, facing the right, towards the female figure, which may, as the superscribed legend indicates, be Mahālakṣmī.

Śeṣa, very elegantly and delicately drawn, spreads its many hoods as a *chatra* over the figure of Kṛṣṇa. Śeṣa's representation corresponds closely to the painting of Kāliya in 'Kāliyadamana' of the 18th century Kangra art.¹⁰³

On the bed of the sea is a demon, half human and half animal in form, with a long tail and long ears, lying prostrate, face downwards, apparently killed by the Kūrma god.

Above the line of water towards the middle of the panel is a small strip, pale yellow in colour, indicating the shore. Further above is a brick-red background, and on the top-most extremity is a narrow bluish band, indicating the sky.

Facing the Kūrma incarnation is the figure of a lady, possibly Mahālakṣmī, in profile, sitting on a raised seat, on which a circular cushion is spread. She is sitting in a *padāmsana* pose, with her left hand stretched out towards the figure of the god. On her right is a female wisk-bearer. Both are dressed in the usual contemporary style.

¹⁰⁰ Vide Coomaraswamy, *Rajput Painting*, Vol. II, Pls. V and XLIX (A and B)

¹⁰¹ Cf. *JUB*, May 1938, pl. V.

¹⁰² cf. पृष्ठभ्राम्यदमन्दमन्दरगिरिप्रावाप्रकण्डूयना -

भिद्रालोः कमठाकृतेर्भगवतः श्वासानिलाः पान्तु वः ।

यत्संस्कारकलानुवर्तनवशाद्देवानिभेनाम्भसो

यातायातमतन्द्रितं जलनिर्भेनाद्यापि विश्राम्यति ॥- *Subhāṣitāvalī*, 36; also cf.

Ibid. 61; *Śārngadhara-paddhati*, 124, *Saduktikarṇāmṛta*, I, 38.

¹⁰³ Vide Coomaraswamy, *Rajput Painting*, Vol. II, plates XLIX (A), and LIII.

To the left of the incarnation is the figure of a Brahmin, or perhaps a *rishi* dressed in yellow *pītāmbara*, and a white scarf thrown over the shoulders, with hair tied up in a top-knot. His head is bent towards the Kūrma god, and his hands are folded in an attitude of worship.

To the extreme left is drawn half view of a plaintain tree in order to fill up the empty space.

The figure of the Kūrma is very delicate and graceful, while the figure of the Brahmin expresses devotion. The figure of Śeṣa, very elegantly and powerfully drawn, is indeed a masterpiece.

In Majmudar's *Gīta Govinda* Ms of the 15th century the Kūrmāvatāra is shown as a tortoise silting on a seat, worshipped by two ladies.¹⁰⁴

The third incarnation is that of Varāha. The Varāha god is represented by a mighty human figure, with a boar's head, and blue in complexion like Viṣṇu. Varāha is wearing a yellow *pītāmbara*, a white scarf and a golden crown. His four hands bear the usual four attributes of Viṣṇu. On his tusk is balanced a huge hemispherical basin with a small figure of a sitting woman inside. It is Pṛthvī, the Earth, rescued from the tyranny of Hiraṇyākṣa.¹⁰⁵

The demon is shown in the foreground towards the right, with a head of a beast, with horns and a tail, killed and trampled upon by the Boar-god.

Two chowri-bearers whisk the god with chowries on two sides. They are clad in white *angarkhās* and coloured pyjamas, and wear *Rājasthānī pagaris* on their heads.

The lower background is light green and the upper brick-red approximating to vermillion. On the top is a narrow bluish strip indicating the sky. In the foreground on the left of the god is shown water with lilies rising up and a little above it is a stately mango-tree. On the right is painted half-view of a plaintain tree for symmetry.

The picture is very skilfully drawn and is in a good state of preservation. The outline of the figures is very delicate and precise, and the boar-god's representation reveals considerable animation and power combined with grace. There is a happy blending of the real and the ideal in the painting.

In Majmudar's *Gīta Govinda* miniatures Varāha incarnation is represented by a conventional figure of a man with a boar's head. It is

¹⁰⁴ *JUB*, May 1938, p. 130. plate VI.

¹⁰⁵ cf. हयैत्यकुटुम्बिनीजनमनःसंतोषसंकोचनः

कुर्याद्विश्वमनश्चरं स भगवान्क्रोडावतारो हरिः ।

यद्गङ्गाकुरकोटिकोटरकुटीकोणान्तरस्थेयसी

• पृथ्वी भात्यवदातकेतकद्वालीनेव सृज्जानना ॥- *Sārngadhara-paddhati*, 126; also cf. *Ibid.* 83; *Subhāṣitāvalī* 7, 30 and 64; *Saduktikarpāṇḍita* I; 39.

in a sitting posture and is holding a *khatvāṅga* and *triśūla*. He is worshipped by two male and one female figure. The figures are conventionally drawn and the incidents are not fully brought out.¹⁰⁶

Nṛsimhāvātāra is also an admirably drawn picture. The background is grey violet. In the centre is a colossal figure of Nṛsimha who has risen from within the pillar which he has rent asunder. It has a human body and a lion's face and its tongue is lolling out.¹⁰⁷ Around his head is a star-shaped halo. The space within the two fragments of the pillar, behind Nṛsimha, is painted blood-red, perhaps to indicate that the pillar was red-hot when it split. It serves as an appropriate background for Nṛsimha and gives a singular effect to the picture. Nṛsimha is sitting on a green seat, which should be the threshold of the palace. On his lap is thrown the demon Hiraṇyakaśyapa, firmly pressed between the god's thighs.

The demon's belly is rent by Nṛsimha, and his entrails are drawn out. The demon's form is, as usual, half human and half animal, and he is shown as wearing a red *pīlāmbara*.

On the right of the god are two male figures in Rajput dress. The nearer one, holding a rosary in his folded hands, is Pralhāda. He is wearing a red *angarkhū* and a red *pagari*. His hands are folded in obeisance to the god, and his face expresses relief and gratitude towards him, whose sudden and mighty manifestation saved him from a fearful death. Behind him is the figure of a young boy, interesting with his wooden slate held in the left hand and a long pigtail fluttering behind.

On the left of the god is a female figure, with folded hands, stooping forward, in an attitude of worship. The legend above suggests that it is Lakṣmī, which is confirmed by the account of Nṛsimha's manifestation given in Bhāgavata. She is dressed in a yellow skirt, a red *sāri* and a blue bodice, with all the usual feminine ornaments.

As the incident happened inside the demon's palace the painter has attempted to suggest the interior of the palace by drawing two stately pillars on the two extreme sides supporting the upper superstructure. The sky is just visible above the parapets of the palace.

In Majmudar's 15th century *Gīta Govinda* miniatures Nṛsimha's figure is conventionally drawn, dressed in a jacket with horizontal stripes, covering up the arm. His upper hands are holding a club and a lotus, while the lower hands are tearing open the bowels of the demon. The latter looks more like a normal human being than a demon. A young boy is sitting in the front, while three female figures are shown in different planes. Curiously enough the Lion-god is shown as having a small

¹⁰⁶ JUB, May 1938, pl. VII.

¹⁰⁷ cf. प्रेङ्गुस्वरकेशरीचरितत्रैलोक्यसन्ध्यातपो

ब्रह्माण्डोदररोषिषर्षरसघ्नकारप्रचण्डध्वनिः ।

स्फूर्णद्वजकठोरधोरनसरक्षुणासुरोरस्थली-

रक्षास्वादविदीर्णदीर्घरसनः पायान्तृषिहो जगत् ॥- *Saduktikarṇāmṛta* I, 40, 3;

also cf. *Ibid.* I 40-42; *Subhāṣitāvali*, 6, 52 and 53; *Śaṅgadharaṇapaddhati* 84, 126.

trunk like an elephant or Gaṇeśa. The trunk is yellowish and is spotted with round red dots like a *cheetah*.¹⁰⁸ There is definite boldness and ornamentation in the painting, but it lacks the remarkable power and vigorous action of the Nṛsiṃha painting in the present *Daśāvatāra Citra*. In the latter all the details of the story are carefully established, and the facial expressions are also expressive—Nṛsiṃha's powerful face radiating *abhaya*, and Pralhāda's face showing relief, joy and devotion.

The fifth picture is that of Vāmanāvatāra. It is in a good state of preservation and is extremely interesting from the point of view of contemporary costumes and social life.

Against a light yellow background are drawn the figures of King Bali and his queen, Vāmana, and Śukrācārya, the preceptor of the demons.

Bali is shown as pouring sacrificial water in the right hand of Vāmana, which symbolises a promise to grant the latter anything he desired. As Bali has just stepped out from a sacrificial ceremony, he is aptly dressed in a yellow *pītāmbara* and a white *upavastra* or scarf, instead of the usual Kingly robes. His hair is gathered up in a top-knot just like a Brahmin's. He has a moustache but no beard. A *kumkum tilaka* is marked on his forehead. On his hands are golden *kaṭās* or *valayas*. He is bending forward a little in order to be able to reach the hand of the dwarfish god Vāmana. In his left hand he is holding a *jhārī* or a nozzled jug of water. He is looking at Vāmana intently and thoughtfully. Perhaps, he is pondering over the advice of Śukra to desist from making the gift.

Vāmana is standing towards the left of Bali. He is represented as a Brahmin, unusually stunted in stature, looking like a *rishi* with his white flowing beard. He is wearing a white dhoti, and has covered his shoulders with a red scarf. He is wearing a white turban, which is rather noteworthy on account of its close correspondence to the present-day Kāthiāwārī *pagari* and its marked difference from the Rājasthānī *pagari* of the Rajput attendants in other pictures. He is holding a lovely little silken umbrella, red in colour. He is holding out his right hand to receive the sacrificial water which is being poured by Bali. In his left hand is a small *kamaṇḍalu*—a gourd. He is gazing steadfastly at Bali, watching perhaps the working of his mind.

Behind Vāmana, to his left, stands Śukrācārya. He is dressed in a red *pītāmbara* and a white scarf. He has a top-knot but no beard. Like Bali he too is wearing a necklace and jewelled earrings. By his right hand upraised he asks Bali to stop, while his left hand points towards Vāmana, perhaps revealing to Bali the real identity of Vāmana, and advising him to desist from making this disastrous gift.¹⁰⁹ His eye is flashing fire reflecting his angry disapproval of Bali's action.

¹⁰⁸ JUB, May 1938, pl. VIII.

¹⁰⁹ cf. स्वस्ति स्वागतमर्थ्यहं वद विभो किं दीयतां मेदिनी

का मात्रा मम विक्रमत्रयपदं दत्तं गृहीतं मया ।

मा देहीत्युशानाः कुतो हरिरयं पात्रं किमस्मात्परं

• यो हीत्यं बलिनार्चितो मन्त्रमुखे पायात्स वो वामनः ॥- *Subhāṣitāvali*, 86; also

cf. *Ibid.* 56, and 59; *Śārngadhara-paddhati*, 127; *Suduktikarṇāmṛta* I, 43-44.

Behind Bali, on his right, stands Bali's queen, stooping forward a little, dressed in blue skirts, a yellow bodice and a red *sārī* of transparent material. As the artist is aware that she is the queen of a *cakravartin*, she is painted in elegant dress and numerous costly ornaments. She had drawn her *sārī*-fringe in a *ghuṃghaṭa* with her left hand, perhaps because the elders like Śukra are present. Her face reflects satisfaction and joy at Bali's gift.

None of the figures wear shoes—perhaps because they are all engaged in sacrificial ceremonies.

On the extreme left behind Śukra is painted half view of a tree, while on the extreme right is shown the interior of Bali's palace, from which they have just emerged to receive Vāmana. The walls of the palace are painted deep red. There is a sumptuous bed-stead, with a round green cushion, occupying a major portion of the floor. The bed is covered with a yellow bed-spread with a bluish fringe. There is a white object with a handle on the bed, perhaps a mirror. Below the bed is a dark footstool. A portion of green canopy hanging down from the ceiling is just visible. In the wall is a niche, containing a green pitcher. The architecture of the palace is imposing enough with its graceful arched pillars, delicate eaves and parapets. Above the palace a portion of the sky is visible.

Some one has inscribed on the topside on the yellow background a few lines from some mediaeval Gujarati text, from which the following verse is decipherable.

अदक लोभ मुजने नही वामन बोले मरम ।
मढी करवा मेदनी मागु त्रणज करम ॥ ¹¹⁰

“Vāmana says slyly : ‘I shall not be very greedy. I want land of the measure of just three steps to erect a hut’.”

In Majmudar's 15th century *Gīta Govinda* Ms Vāmana is drawn not as a *baṭuka* but as a normal man, sitting on a circular seat, bearded, wearing a yellow dhoti with red spots, a red scarf and a crown. Bali is standing on his left in a suppliant mood. One woman is offering something to the god, while another woman is shown running towards him with a lotus. The outline is indeed bold and colouring is warm, but the details of the story are not effectively worked out.¹¹¹

The Vāmanāvatāra painting in the 16th century *Gīta Govinda* Ms published by Majmudar, is rather weak with its crude and inartistic portrayal of Bali, and the indifferent representation of Vāmana.¹¹²

¹¹⁰ I cannot trace these lines to their original text. Premānand's *Vāmanacaritra*, however, gives some lines which are closely similar, e.g.

लोभ नथी तिल जेटलो मुने आश्रमनुं छे काम ।
पर्णकुटी रहेवा जेटली बीजी वस्ते नहीराचुं ।
त्रण डगलां मारां धरं, एटली मही जाचुं ॥.....
त्रण कदम अवनी विषे बांधुं एक मढी ।

—*Vāmanacaritra*, *Kadavū* 12, *Bṛhatkāvyaśāhā*, Vol. II, 3rd edn., pp. 280-281.

¹¹¹ *JUB*, May 1938, pl. IX.

¹¹² M. R. Majmudar, 'An Illustrated Ms of *Gīta Govinda*,' *JUB*, Sept. 1941, p. 120, pl. II.

In the present *Dasāvatāra Citra* Vāmana's painting is a veritable masterpiece. The outline is very delicately executed, the colouring is warm and judicious, and the portraiture is expressive. Bali's face reflects pensiveness and determination, the Queen's reflects joy, and Vāmana's face reveals watchfulness. Śukra's face is the most expressive of all—his eye flashing fire and his upraised hand commanding Bali to stop. Within the limitations of the tradition of stereotyped portraiture in Gujarati and Rājasthānī painting, the artist has attempted to achieve noteworthy expression of moods and feelings.

The sixth painting depicts Paraśurāma in his epic fight with Sahasrārjuna.

The foreground has been left uncoloured so that the original brownish colour of the paper might suggest open ground. Above it is a blue background and at the two extremities are drawn half-views of two trees. One of them is a plantain while the other with large round deep green leaves cannot be easily identified. It could perhaps be the *pippala* tree. At the top is, as usual, the blue sky, differentiated from the background by the irregular thick white line of the horizon.

Against this background stand out clearly and forcibly the figures of Paraśurāma and Sahasrārjuna. Paraśurāma is on the right dressed partly like a Brahmin and partly like a Kṣatriya. He is wearing a yellow *pīlāmbara*, a white scarf over the shoulders, and the usual ornaments like necklaces, *kaḍās*, and the earrings. He has no beard, and his side whiskers are very noteworthy. Like a Kṣatriya he has Rajput type of shoes on, a *mukuṭa*, and a number of weapons on his person. His uplifted right hand is brandishing his celebrated *paraśu* or axe, while in his left hand is a shield inwrought with four gold and diamond floral patterns. A strong rope is tied to the shield and its loop worn round the neck, evidently to prevent the shield from being knocked down by his opponent's blows. At the back of Paraśurāma's waist is tied a bow, and on the right is a quiver of arrows, while on the left a sword dangles. On the right side is seen the golden hilt of a dagger, thrust in the waist-band.

To the left of Paraśurāma and facing him is King Sahasrārjuna, dressed in the usual Kṣatriya fashion. He has a red *jāmā* on, fastened to the waist by a green scarf tied round like a waist-band. The *jāmā* in all these paintings shows some loose ornamental side flaps fluttering on the left side. Their exact pattern is seen conspicuously in the figure of Kansa in the *Kṛṣṇāvatāra* painting. Perhaps the flaps were not entirely decorative, but served the purpose of buttons. On the lower part of the body Sahasrārjuna is wearing yellow pyjamas. He has a golden *mukuṭa* on and has Rajput shoes like Paraśurāma. In mythology he is described as having a thousand hands. The artist has shown seven hands on the right and nine hands on the left, while four hands shown as fallen on the ground severed by the mighty axe of Paraśurāma. In his hands he is wielding different weapons. The topmost hand on the right is brandishing a broadsword; the next is thrusting a spear at Paraśurāma; the third one is holding forward a shield to parry Paraśurāma's blows; the next one is thrusting out a short broad dagger; the one below is carrying an outstretched bow; the one lower still

is on the hilt of a sword-case perhaps drawing out the sword; while the last one on the right is on the waist-band, appearing to be drawing something out of it. Of the left hands the topmost is holding a white stick-like thing, perhaps a *khaṭvāṅga*. The next is fixing an arrow in the bow, while the third one is flourishing a long sword. The fourth one is holding a golden mace, and the one below is clenched. The next three hands are engaged in drawing out arrows from the quiver, tied at the back of the waist. The lowest one is resting on the waist, perhaps drawing out some weapon. On the ground between him and Paraśurāma are fallen his four hands.

The picture is a remarkably powerful depiction of a duel, complete in every detail. Paraśurāma's face is full of rage, and his right leg bent back, and his right hand lifted up to its full length to deal a mortal blow with its ponderous axe, are eloquently expressive of his colossal strength.¹¹³ Sahasrārjuna's receding figure, shows how he is gradually losing ground. Perhaps he is conscious of his certain doom and is afraid to face it.

The painting is fairly well-preserved and is singularly successful in its representation of the Heroic (*Vīra rasa*). Several of the paintings of this album represent combats, but none with such powerful effect.

Above the skyline, on the topmost part of the panel is written :

मारा मुनीजन बन अपराधे, कामधेन ले जायू ।

बार एकच नक्षत्री कीनी तांहां न देखे हाउ ॥

Down below, in the foreground, beneath the severed hands is written हाथ पड़ा छि.

In Professor Majmudar's 15th century *Gīta Govinda* Ms Paraśurāma's incarnation is represented in the same manner as Vāmanāvatāra. Paraśurāma is shown as sitting on a green cushion, wearing a yellow dhoti with blue dots, a yellow scarf, and a red *mukuta*. He has four hands, of which the upper two are holding a mace and a trident (and not the *paraśu*), while the lower two do not carry any weapons. Two women on different planes appear to be worshipping the god with some offerings. A charming *chatra* or canopy is suspended from the ceiling.¹¹⁴ The paintings in this 15th century *Gīta Govinda* Ms stop short at Paraśurāma incarnation; the rest of the paintings of the avatāras seem to have been lost.

The seventh *avatāra* is the Rāmāvatāra. The Rāmāvatāra painting is a very elaborate picture of war between two *Rathins* or charioteers. It is very rich in detail, but it lacks the vigorous action and the powerful effect of the Paraśurāma painting.

¹¹³ cf. हा तातेति न जल्पितं न रुदितं न स्वाकृतं तद्वनं
न स्नातं न च वीक्षितः परिजनः पित्रे न दत्तं जलम् ।

यावन्न क्रकचाभिघातविगलद्दाम्नामरीणामसु-

गण्डूवैर्धनघोरघर्षरवाः सन्तर्पिताः फेरवः ॥- *Saduktikarṇāmṛta* I, 45, 2; also

cf. *Ibid.* I, 45; *Sarṅgadharapaddhati*, 128.

¹¹⁴ *JUB*, May 1938, pl. X.

The foreground of this miniature is painted blue, but it does not signify water, as the waves are not shown and the upper boundary line is absolutely regular. Above it is yellow background. At the top appears, as usual, the blue sky. As the picture is crowded with details no trees or landscape could be shown.

On the right are shown Rāma and Lakṣmaṇa in a chariot drawn by two horses, which are dark Indian red in colour. They are drawn realistically but not elegantly. Rāma is occupying the front seat, where the charioteer usually sits, while Lakṣmaṇa is sitting inside. The chariot is an open one, like the present-day *ḍamaṇī*. The two wheels, drawn in the usual Rājasthānī technique lacking in depth, appear to be in the same plane. Rāma is deep blue in complexion and is wearing a coat of mail on a white *jāmā*, and has saffron coloured pyjamas on. On his head is a lovely golden *mukuṭa*, and on his ears are diamond earrings. He has drawn his legs under him. He has wound a saffron-coloured scarf around his waist, in which a golden hilted dagger is fixed. He has stretched a bow to the full, to which a crescent-pointed arrow is fixed.¹¹⁵ From the right side of the waist is suspended a quiver of arrows, while on the left side is seen a sword in a red case. He has no shoes on and wears no beard.

Inside the chariot is sitting Lakṣmaṇa dressed and armed in an identical manner. He has a white waist-band scarf. He has not yet drawn the bow. With his right hand he is taking out an arrow from the quiver. He wears a short beard, which makes him look older than Rāma. If Rāma were not distinguished by his blue complexion Lakṣmaṇa might have been mistaken for Rāma.

The strappings of the horses are noteworthy.

On the left is the ten-headed Rāvaṇa, sitting in a chariot similar to Rāma's, but much larger, and conspicuous by the asses harnessed to it. In front of him is a charioteer, dressed and armed like Rāma and Lakṣmaṇa. Rāvaṇa's ten heads are shown in a peculiar way—first one set of five heads is shown, and above it the other. The upper set of heads are wearing *mukuṭas*. Of his hands ten are shown on the right holding different weapons, while the rest are painted on the left. As the picture has been ill-preserved, some of the hands on the left are not fully visible, only their red outline surviving. Rāvaṇa is wearing a huge coat of mail on a white *jāmā* covering along with the upper part of his body all his arms. He has tied a dark-coloured scarf round his waist and fixed a dagger in it. The lower part of his body is covered in an orange-coloured *pīlāmbara*. He wears no beard and has no shoes on. Of his right hands one is holding a fully drawn bow with an arrow fixed to it, another is holding a shield, while the others are brandishing a broad-sword, an axe, a pointed sword, and a spear. The uppermost right hand is on the chin of the topmost head on the right side,

¹¹⁵ cf. रामः कस्य न विस्मयाय मनसो निःशङ्कलङ्केश्वर-

शुभ्रमौलिसिरासः, च्छलदसुधारानुबन्धेन यः ।

तद्दोर्विचिक्रमविद्रुता दशदिशो भोगाय भूमण्डले

सम्यग्वासयितुं प्रबालघटिता यष्टीरुदस्तम्भयत् ॥—*Saduktikarṇāmrta* I, 48, 2;

also cf. *Ibid.* I, 46 and 47; *Sarvagadharapaddhati*, 129,

in a thoughtful attitude, while the lowermost two hands are resting on the waist. Of the left hands only the second from the top is seen holding a mace, while the lowest but one is drawing out arrows from a quiver fixed on the backside of the waist a little towards the left. He has two legs only, which are drawn in a *padmāsana*-like posture.

High above between Rāma and Rāvaṇa is Hanumān jumping towards Rāvaṇa's chariot with a big boulder in his hands. He is painted like a monkey, but has red shorts and a white scarf on. The names of the *dramatis personae* are written at the top in crude hands, while below the figures of the asses is remarked रावणनो रथ गच्छो.

Thus the picture of Rāmāvatāra though very rich in detail cannot compare with the painting of Paraśurāma in the powerful representation of the Heroic sentiment. Rāma's figure is poorly drawn and lacks expression. The faces of Rāvaṇa, particularly the first two heads facing Rāma reflect sternness and anger. As the artist has shown Rāma and Rāvaṇa fighting seated in a chariot he could find no scope for representing expressive postures and poses. The usual powerful delineation is, therefore, lacking in this painting.

The Rāmāvatāra painting pointedly reminds us of the charming Pahari (Jammu) pictures of 'Lankā Kāṇḍa,' 17th century A.D.,¹¹⁸ where Rāma and Lakṣmaṇa are shown in a camp, at some distance from Laṅkā, discussing with Vibhīṣaṇa. All the three are clad in coats of mail. Rāma is dark-blue, while Lakṣmaṇa has a fair complexion. Vibhīṣaṇa is conspicuous by his short beard. All the three figures are delicately and effectively drawn. Rāma's army of monkeys in combat with Rākṣasas is also well-drawn.

Facing them at a distance is the huge castle of Laṅkā, where Rāvaṇa is sitting in a prominent place at the top. He has ten heads, which are shown linearly, five on one side and five on the other. All the heads are bearded and have one huge *mukūṭa* covering them all. He is conferring with his generals.

The next plate (XXIII) shows Rāvaṇa, bearded, with Śaivite *tripuṇḍras* on his foreheads, clad in a flower patterned robe and large *deśī* shoes, on a visit to Sītā in Aśokavāṭikā.

The painting of Rāmāvatāra in the present album cannot compare with these beautiful Pahari paintings. Perhaps the limitation of drawing seated figures was too much for the artist leaving him little scope for expressing vigorous action. The picture has also suffered much on account of its defective preservation.

The next miniature depicts Kṛṣṇa's fight with Kansa. The figures are fairly intact, but the green background has been considerably damaged. Perhaps it was the result of somebody's removing some writing on the background between the main figures.

The foreground, drawn in faint violet, indicates the palace floor. Above it is the green background covering the entire panel. At the top a small portion of the sky is just noticeable.

¹¹⁸ Coomaraswamy, *Rajput Painting*, II, pl. XXI and XXII.

On the extreme right is Balarāma, white complexioned, wearing a red *pīlāmbara*, a yellow scarf, a golden *mukuṭa*, and red Rājasthānī shoes. He has golden *kaḍās* on the hands and a golden chain round the neck, but no other ornaments. He does not carry any weapon.

Next to him to the right is the figure of Kṛṣṇa. He is blue in complexion, and has put on a yellow *pīlāmbara*, a white scarf, a golden *mukuṭa* and red Rājasthānī shoes. His gold and diamond necklaces and diamond earrings are very conspicuous. In his right hand is a white elephant tusk (probably extracted from the head of Kansa's elephant Kuvalayāpīḍa, killed by Kṛṣṇa) while his left hand has seized the long locks of Kansa. His right leg is slightly drawn in, and he is bending forward to deal Kansa a powerful blow.¹¹⁷

Kansa is shown sitting on a typical *śimhāsana* or throne, to which a *chakra* is attached. While he was sitting on it he was dragged down by Kṛṣṇa, by seizing his hair. He is wearing red pyjamas with dark stripes, a typical *jāmā* with free side-flaps, a white scarf tied like a waist band, and gold and diamond necklaces. In his right hand he has a dagger, which he is thrusting at Kṛṣṇa, but in vain. His *mukuṭa* has tumbled off during the struggle. Behind him stands a woman dressed in the usual fashion. She has a chowri or wisk resting on her left shoulder. From the legend (मायी) above the figure it may not be incorrect to deduce that she is Kansa's wife, though her plain dress and her chowri makes this interpretation a little uncertain. Her hands are folded in homage to Kṛṣṇa, while her chowri is resting on her shoulders.

On the extreme left is shown the interior of a palace, precisely in the style witnessed in Bali's picture. The architecture is very much similar, though the projecting balconies and the latticed windows are additional noteworthy features of this painting. The walls are brick-red with a niche inside, where a small blue pitcher is kept. On the floor is a sumptuous bed-stead, richly covered, with round long cushions. A small footstool is placed below.

The picture is rather mediocre. Kṛṣṇa's posture suggests strength and action, while Kansa's subdued posture shows his helplessness and confusion. The faces, however, are quite conventional and do not suggest any feelings. The colour-harmony of the picture is, however, quite attractive. Kansa's very conspicuous *jāmā* is an interesting feature of this miniature.

Kṛṣṇa's figure has been almost invariably rendered indifferently in the Gujarati paintings known so far. Even in Mr. N. C. Mehta's *Gīta Govinda* paintings, which are aesthetically much superior to the rest of the early Gujarati Vaiṣṇava paintings, Kṛṣṇa's figure is not artistically portrayed. Whether this was a consequence of the unusual

117 cf. मल्लैः शैलेन्द्रकल्पः शिशुरखिलजनैः पुष्पचापोक्तनाभि-
गोपैस्तु प्राकृतात्मा दिवि कुलिशमृता विश्वकायोप्रमेवः ।
कुम्भः कंसेनकालो मयचकितदृशा योगिभिर्भयमूर्ति-
दृष्टो रत्नावतारे हरिरमरजनानन्दकृष्णो युष्मान् ॥

— *Subhāṣitāvalī*, 48; cf. also *Ibid.* 33; *Sārngadhara-paddhati*, 130,

complexion of the figure which did not easily lend itself to graceful treatment, or whether it was due to other factors, we do not know.

The ninth incarnation is the Buddha's.¹¹⁸ It is fairly well-preserved. The background is in brick-red and at the top is a small portion of the horizon. In the middle is a raised platform with steps descending on either side, resembling the interior dais of the Vaiṣṇava temples, where the idol is placed. On the platform is a red *śimhāsana*, with a cushion in the middle, on which Buddha's figure is seated. He is shown as blue in complexion, like Kṛṣṇa, and appears rather young. He is dressed in a yellow *pītāmbara*. He is presented not in the profile, but in the full frontal view, which is rather unusual in the mediaeval Gujarati painting. It is only restricted to the representation of *Tīrthaṅkaras* and looks rather flat and inartistic on account of its want of depth. Buddha is wearing a crown, with three crests very much like the peacock feathers, and several ornaments like *kaḍās*, armlets, earrings, etc. Curiously enough he is shown with a triangular *tilaka* on the forehead. This is evidently a slip of the artist who appears to have been carried away by the prevailing tradition. Buddha's figure looks very much like an image on account of its frontal representation.

There are two lamps, one to the right and the other in front of the figure. On either side of Buddha stands an attendant, whisking the lord with a chowri. The attendant on the right is dressed in a yellow *jāmā*, an orange scarf, used as a waist-band, green pyjamas, and an orange coloured *Rājasthānī* turban. He has no shoes on. By his right hand he is whisking the Lord with a chowri, while in his left hand is a dish with flowers and some offerings.

The attendant on the left is dressed in a saffron *jāmā*, a green waist-band scarf, yellow pyjamas and a green turban. He too has no shoes on, perhaps because he is waiting on the Lord. He is whisking the figure with a chowri by the right hand.

On the extreme right is seen half view of a plantain tree, while on the extreme left is half view of some tree with round deep green leaves, like the one in the *Paraśurāma* painting.

The most striking feature of the *Buddhāvātāra* painting is its frontal delineation of the figure of Buddha. In the present paintings all the other figures including even these whose entire body faces the front, are drawn in profile. In contrast the Buddha's figure immediately stands out. It is, however, flat and inartistic, like all similar frontal representations, on account of the lack of perspective. Buddha's bluish complexion is another interesting feature of this picture. Perhaps this colour is intentionally used in order to emphasise Buddha's identity with Viṣṇu, who has a characteristically bluish complexion in every incarnation.

¹¹⁸ cf. कामक्रोधौ द्वयमपि यदि प्रत्यनीकं प्रसिद्धं
हृत्वा नम्रं किमिव हि रुषा साधितं त्र्यम्बकेन ।

यस्तु क्षान्त्या शमयति शतं मन्मथादीनरातीन्

कल्याणं वो दिशतु स मुनिप्रासणीरकबन्धुः ॥- *Saduktikarṇāmṛta*, I, 49, 1; cf.

also *Ibid.* I, 49; *Subhāṣitāvalī*, 74; *Sārngadharapaddhati*, 131.

The attendants are drawn with considerable care and delicacy. Their faces are quite realistically portrayed, seeming almost to be life-like. Their poses too are quite expressive and harmonise well with the atmosphere of worship which the artist has sought to create.

The album concludes with the painting of Kalki, which is singularly interesting in many respects.

In the foreground is shown a river. There are lotuses inside, and their delicate leaves have spread close to the bank. Just above is a small strip in pale brown, indicating a road, running close to the river. Further above is a greenish blue background, and on the topmost part of the panel is the sky, as usual, in pale blue.

The centre of the picture is occupied by the divine horse of the Kalki incarnation.¹¹⁹ It is drawn with consummate skill and can compare favourably with later Rājasthānī and Pahārī equestrian paintings. It particularly reminds us of the Pahārī (Jammu) painting of a horse, entitled 'The Points of the Horse,' belonging to the 18th century.¹²⁰ In both the paintings the outline of the horse is precise. The legs are slender and graceful, with one of the front legs raised, and the hind part is broad. The only difference between the two figures is that the Pahārī painting shows the figure of the horse in black, and without saddle or strappings, while in our Daśāvatāra album it is in white and is sumptuously equipped.

In the *Daśāvatāra* paintings the Divine Horse is entirely white. Its foreleg has been lifted up. The short ears are standing erect and the nostrils are expanded. It has an expansive chest, a broad hind part and a flowing tail. It has two wings rising from the chest, to indicate its divinity. It has elaborate and rich strappings—an orange coloured saddle, an ornamental chest-strap, and a golden bridle. It has dainty *toḍas* on all the four legs. On the saddle is attached a red *chatra*.

No one is riding on the horse, but a figure is standing in front of it towards the right holding a rope attached to the bridle. That is the Kalki incarnation.¹²¹ Kalki is richly dressed in a white diaphanous *angarkhā* with side flaps, a white waist-band, saffron-red pyjamas, a golden *mukuṭa* and red Rājasthānī shoes. He has a blue complexion. There is a naked broad-sword in his right hand, while in his left hand is the neck rope of the divine horse. Some one has erroneously inscribed the legend 'शिवक' above the figure of Kalki, and 'कलकी' on the hind part of the horse.

On the extreme right is painted half-view of a plantain tree, with a bunch of red plantains hanging from the lowest branch. To the left is a tall palm-tree and next to it a stately mango-tree with yellow blossoms seen here and there.

¹¹⁹ cf. उद्यत्करकरवालः शक्तिमिरध्वंसने महानिपुणः ।

कल्किहरिर्वः नायादपायतः कलिनिशान्तोत्थः ॥

—*Śrīrṅgadharaṣaddhati*, 132; also cf. *Saduktikarṇāmṛta*, I, 50.

¹²⁰ Coomaraswamy, *Rajput Painting*, Vol. II, Pl. XXXIII.

¹²¹ Cf. *Bhāgavata*, Skandha XII, adhyāya 3.

This picture is remarkable for its charming figure of the horse and landscape. Its outline is very delicate and realistic, and the treatment effective. The winged representation of the divine horse is a striking feature. Perhaps it was borrowed from alien art, or perhaps it was suggested by the mythology and the folk-lore, which frequently refer to winged horses.

VIII

Let us now recapitulate in brief some of the important results of our study.

The *Daśāvatāra Citra* marks an important landmark in the history of Gujarati miniature painting.

It is the first complete set of the *Daśāvatāra* pictures in Gujarati style to come to light so far, and is aesthetically superior to all other similar paintings. It does not represent the classical art of the period, but it is a product of the folk-art fused with Vaiṣṇava hieratic tradition. Within the limits of the contemporary technique, such as the want of perspective, stereotyped facial expressions, conventional painting of landscape, and the linear style, the unknown artist has given us some really beautiful paintings. The picture of Vāmana is remarkable for its delicacy of outline and the beauty of its postures; Paraśurāma's picture for its vigorous action, and Kalki's for its charming animal drawing. The remaining pictures also reveal skilful draughtsmanship and remarkable colour harmony. Varāha's figure balancing the Pṛthvī and Nṛsimha's sudden and gigantic manifestation are drawn with considerable power and insight. In the Matsya and Kacchapa paintings the representation of the sea is charming indeed. The painting of animals in all these paintings is quite realistic, and the trees are always painted with consummate skill. The mango-tree in the Varāhāvatāra and the palm-tree in the Kalki painting are masterpieces. The artist is also at home in representing architecture. In their mastery of technique these pictures compare favourably with some of the outstanding specimens of Rājasthānī and Pahārī art. These paintings throw a flood of light on the contemporary life and manners, particularly the costumes.

Comparing these paintings with early Gujarati miniatures we find that they show a greater mastery of outline, a more vivid sense of colour, and a greater fidelity to detail than the earlier paintings. These paintings are far more realistic in the drawing of trees and animals than the early Gujarati paintings. Lack of depth, found in the early Gujarati paintings persists in these paintings too, rendering them somewhat flat. The technique of expressing a variety of moods by gestures and poses, which distinguished the early Gujarati art, has undergone considerable change in the present paintings. The fascinating dance poses which sometimes lifted the earlier art into the realm of poetry, are no longer in evidence. The intense brilliancy of the palette of the earlier art has yielded place to a complex, balanced tonality, which is warm but not gorgeous.

In spite of this divergence from the earlier tradition, the art underlying the *Daśāvatāra* miniatures is essentially Gujarati. The almost regular painting of profile, the preponderance of brick-red and yellow

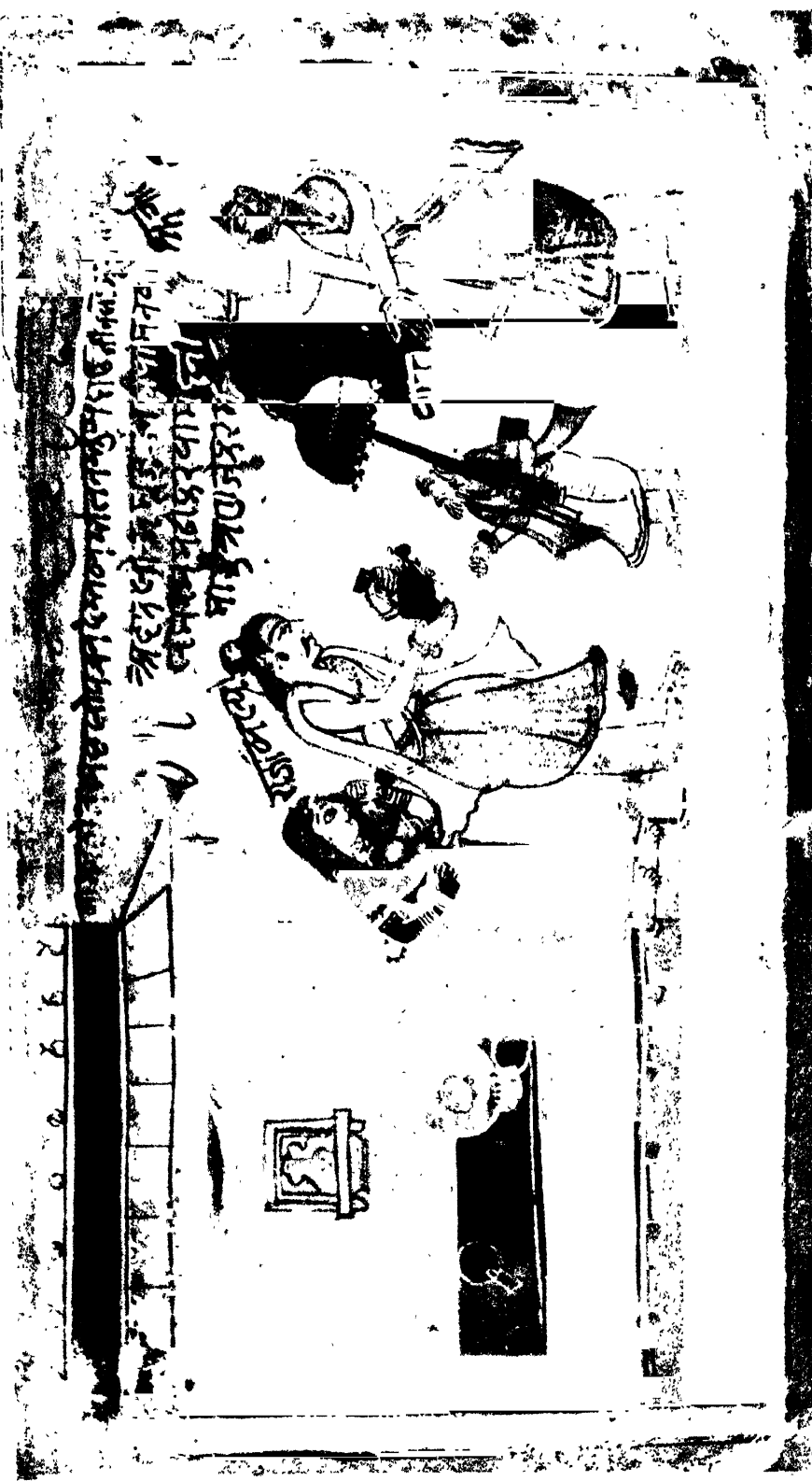








IV. Nisinhāvatāra



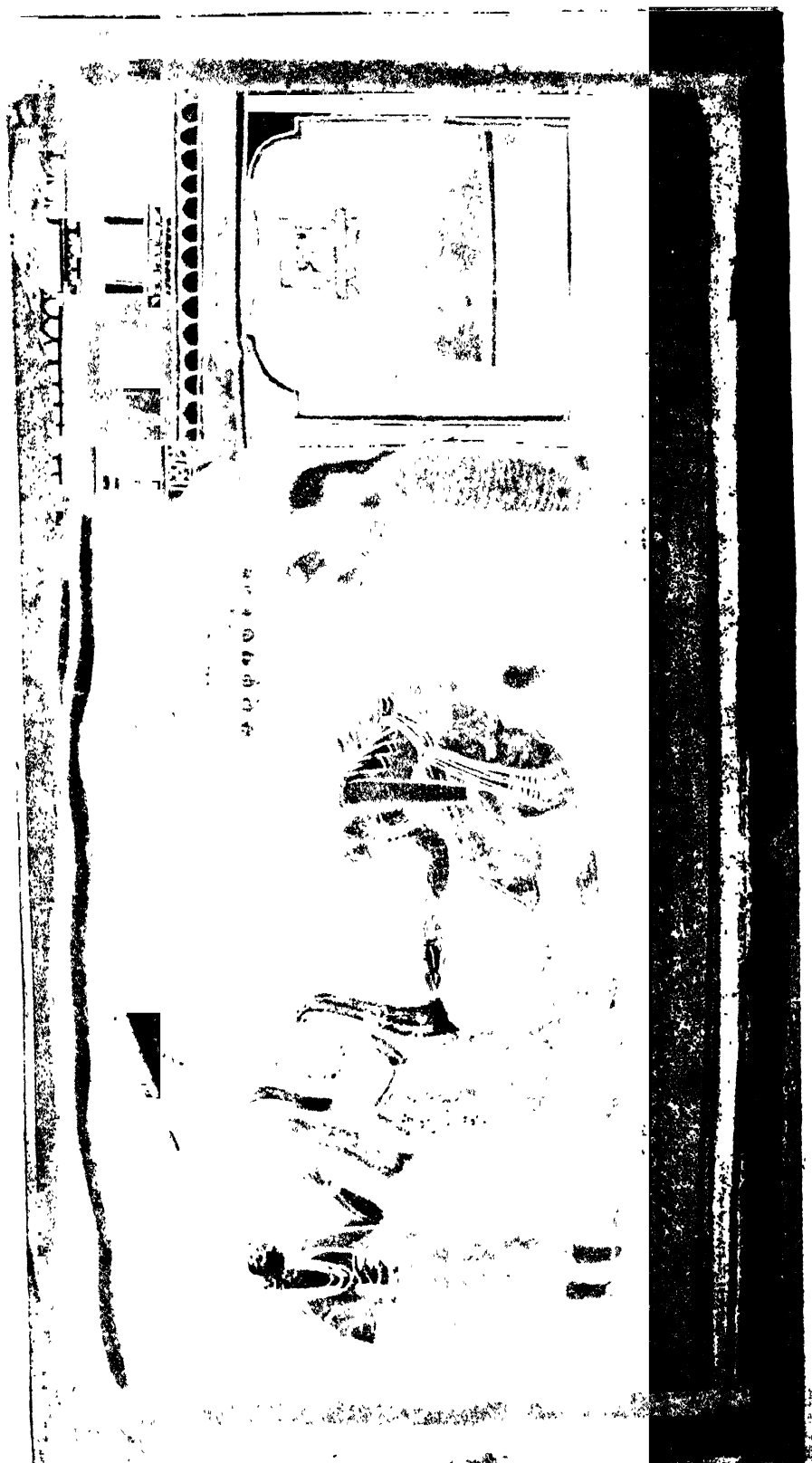
ॐ नमो भगवते वासुदेवाय ॥
अथ श्रीकृष्णार्जुनसंवादे
अर्जुनस्य द्रुपदमुनिश्च
विराट्पुत्रश्चैव ॥







VII Rāmāvatāra





IX — Buddhāvatāra



in the background, the practice of representing the sky at the topmost part of the panel, are some of the characteristic features which establish the identity of the *Daśāvatāra* miniatures with earlier Gujarati paintings. This view derives additional support from the Old Gujarati legends on the *Vāmana*, *Paraśurāma* and *Rāma* paintings, which from their calligraphy, appear to be practically contemporaneous with or only slightly later than the paintings. The findspot of the album is Pāṭan, the capital of early mediaeval Gujarat. There is, thus, overwhelming evidence for assigning these paintings to the Gujarati School, then in its last phase, before its submergence into the Rājasthānī art.

There are indeed traces of the Rājasthānī elements in these paintings. That is, however, not peculiar to these pictures alone. We find that Mr. N. C. Mehta's 16th century Ms. of *Gīta Govinda*¹²² and Professor M. R. Majmudar's 16th century Ms of *Gīta Govinda*,¹²³ reveal Rājasthānī influence, in the matter of costumes, though they are definitely Gujarati in style. It is only upto the 15th century that specimens in pure Gujarati style are met with. After that the Gujarati art starts assimilating elements from the Rājasthānī art and ultimately gets merged into it. This was, as we have seen, a natural consequence of the close cultural affinities between the regions of Gujarat and Rājasthān during the mediaeval period.

The date of these paintings cannot be later than the 17th century. The state of preservation of this Ms, the preponderance of primitive colour-schemes, the evidence of dress, all point to the 17th century as the ulterior limit. The language and calligraphy of the legends above the paintings confirm this date. The legend in the foreground of the *Paraśurāma* painting, for instance, reads as *दृश्य पडा छ*, which, as we shall see, is very significant. *छ* is either *छि*, the curve attached to the right-hand top of the vertical indicating medial short *इ* having been worn out, or it is *छे*, the vertical standing for a *paḍimātrā*. In both the cases—in the earlier on linguistic and in the latter on calligraphical grounds—an early date, 17th century or thereabouts, is indicated. It cannot be later than that. The earlier limit cannot be prior to the 16th century, when the Gujarati art started using the strict profile in place of the earlier three-quarter profile, with the further eye protruding. It would thus be safe to place these paintings somewhere in the 17th century.

The importance of these paintings is considerably enhanced by the fact that non-Jaina paintings, so far discovered, are rather limited, and some of them are very crude indeed. This album is, it appears, one of the few collections of Gujarati paintings, that have a distinct aesthetic value.

I am grateful to Śrī Rāmlāl Chuniāl Modi, for permitting me to study and publish these paintings, and to the University of Bombay for encouraging me in my study of Old Gujarati language and literature by the award of research grants. I am obliged to the University also for reproducing these pictures in colour in such difficult times as the present.

¹²² N. C. Mehta, *JGRS*, Oct. 1945.

¹²³ M. R. Majmudar, *JUB*, Sept. 1941.

A SOCIOLOGICAL STUDY OF THE JATS IN KATHIAWAD

BY B. L. MANKAD, M.A., B.T.

THERE are many communities in India which were originally Hindu but due to certain undue pressure or due to some insurmountable difficulties have been converted to Mahomedanism. In the last so many centuries so many Hindus have been forced by the circumstances to embrace Mahomadan religion. Jats, the subject of this study have in the similar manner been converted to Mahomadan religion.

It is said the Jats are so called because they originally lived in the part of Sindh called Jati. It was situated between Baluchistan and Sindh. From this part of the country they came to Sindh proper and after living and settling there for a number of years they went to Cutch. Though they lived for a number of years in Sindh, Sindh could not hold them because they were a sort of wandering people. They were cattle-breeders—cattle breeders of a high type and so it was impossible for them to stay in a particular place for a long time. They were always on a look out for a good pasture. Wandering people will always find it difficult to settle down to a stationary life. There is a second version that these Jats were originally Rajputs and called themselves Jāts. Their home was in the Punjab. Thence they immigrated to Rajputana. Thence to Sindh, Cutch and lastly to Kathiawad.

They left Sindh as the story goes, because a Sumera chief of Sindh happened to see the daughter of a Jat chief and asked her hand in marriage. To this the Jats objected. The Jats found that it was impossible to resist the Sumera Raja. The result was the Jat Raja realised this and the Jat chief thought that it was in the interest of himself and the people to leave the place and run away in order to save his princess and the reputation of his people. The Jat chief thought it was not possible to stand against the Sumeras and to resist them from achieving their object. So he left Sindh crossed the Upper Runn and going to the Rao Raighan of Cutch requested him to give him a shelter. He requested him to save his honour by helping him to defeat the pursuing army of the Sumera Raja. But as the ill-luck would have it the Rao turned out to be what the Jat chief had not thought him to be. He turned out to be a coward. He said that it was no good his incurring the wrath of the powerful Sumera Raja. He also advised the Jat Raja to seek shelter somewhere else. The Sumera Raja was actually pursuing the runaways with a powerful army. The Jat Raja knew it. He thought it was wise for him to fly from Cutch. So he crossed the Little Runn of Cutch and crossed it for Kathiawad. In search of a shelter, in search

* I do not find sufficient words to thank my Professor Dr. Ghurye who has initiated me to the study of castes, and has been a great help to me all the while.

of protection, he went through Zalawad and came to Muli where a Parmar Raja was ruling over a small kingdom of Muli. He was not a great king, his kingdom was not great but he had a magnanimous heart. He was a real Kshatriya. He knew his duty towards a stranger who was persecuted and who was seeking shelter. He with open arms welcomed the Jat Raja heard him sympathetically and promised to defend the honour of the Jat Raja as if it was the honour of his house. These Parmars had migrated from Marwad and coming to Kathiawad had taken some part of the country round Muli. The Parmar Raja had already consolidated his little kingdom and he was trying to add to his little kingdom by pouncing upon the weaker chiefs. The pursuing Sumera Raja overtook the Jats near Muli and brought them to bay. He forced them to give battle. The Parmar Raja knew the danger. He consulted the wise councillors and even the Parmar Raja consulted his wise old mother. All of them were of one opinion that it was the duty of a Rajput to give shelter to one who comes to seek shelter. The Parmar Raja was prepared to meet the Sumera in a pitched battle, for when the Sumera chief ordered him to hand over the beautiful princess he insultingly refused to do so. We wonder when we know that the Parmar Raja offered his help to the strangers whom he did not know as to who they were and to what religion they belonged. He simply knew his duty and readily prepared to do it. A great battle was fought in which the Parmar Raja and the Jat chief fought as brothers, side by side, swords in hand, like real heroes. The beautiful princess was put to death along with other women of the Jat chief household lest they may fall in the hands of the pursuers. The Parmar and the Jat chiefs fell in the field of battle fighting bravely side by side. Now it so happened that the Jat chief and the Parmar Raja fell side by side but on such a place that the blood flowing from the body of the Jat chief began to be mixed with the blood of the Parmar Raja. This was observed by the Parmar warriors and wished that this river of blood flowing from the body of the Jat should not be allowed to mix with that of the Parmar Raja. But the eldest prince of the Raja observed that the blood's flow should not be checked. By this time, that is to say by the time the battle was over and the Sumeras were victorious in the battle. They pursued the Jats who had begun to run away from the field, in the hope of acquiring the possession of the princess. In this, they had nothing but despair in store for them. For it was after some time that they came to know that the princess was killed along with other women of the family of the Jat chief. The Parmar prince now realised that these Jats were not Rajputs, but the Rajputs who had been converted to Mahomedanism. In memory of this great incident the Jats and the Parmars still call themselves brothers. For the Jats have never forgotten the great obligation done to them by the Parmars who sacrificed their lives, property and everything. Even after the Jats took to a wild life of robbers and dacoits they always remembered the Parmars and the obligation done to them years ago. They even to-day call themselves blood brothers.

Jats could not lay their mighty hand on any part of the country. It appears that either they were weak to assert themselves or the circumstances in which they lived were too unfavourable for them to help them in establishing any power in Kathiawad. They took to or they inclined towards the lower strata of the society. They did not connect themselves with any powerful party. Necessarily, they made friends with Kolis

and other communities like Kathis, Mianas and other peace-disturbing elements. These people were working havoc in Kathiawad. No life or property was safe and the country was dipped in blood of the weak and the innocent who were neither able to defend themselves or to save themselves from these people.

It was after the advent of the East India Company's government in Kathiawad that these, devastators like the Kolis, the Jats, the Mianas were brought to bay. After Col. Walker's settlement a sort of quiet began to be established in Kathiawad. These people were deprived of their arms, their ammunitions and were dealt harshly. The Jats who had been powerful in the northern coast strip of Kathiawad were made to stick themselves to that part of the country. This part is known as Nani Jatwad. Bajana State is occupying a prominent place in this Jatwad. There are many villages. Twenty-four of them are said to be in chief villages in which Jats are still living. In this Jatwad, all these twenty-four villages do not belong to Bajana State but there is one other state called Lakhtar to which these villages belong, and also to British Jillas especially Viramgam District. Jats are also found in the southern part of Gujarat. They are living on the borderland of Cutch. They are under Radhanpur State. This part is known as Moti Jatwad.

It is very interesting to study how these Jats became converted to Mahomedanism. We read in history that more illiterate the people more easy it is to convert them from one faith to another. Whenever they come across anything they do not understand or follow they always think that there is some supernatural agency at work. They always are fond of seeing miracles and when any one shows them miracles they are mad after them and are always ready to do whatever they ask or order them to do. Once they are converted they are converted for good. Once they follow a particular doctrine they cling to it with an iron grip. Missionary efforts or preachings count with them but not so much as some extraordinary thing or what they call miracles. However we hear many Jats talking that though they have been following Mahomadan religion they still cling to their Hindu names and Hindu surnames, it is always very easy to convert the illiterates.

Names:—From their names, their manners, their customs, their dress, their utensils, and from their general physical appearance and last but not the least from their language we cannot but say that they are Hindus and there is a great likeness between the Rajputs and the Jats. They have yielded to force and undue pressure from the Mahomadan Sultans of Gujarat. Even after they settled in the northern part of Kathiawad they could not be familiar with the ruling princes and the ruling princes could not see anything in them to attract them to make them their relatives or friends. Thus the Jats though they belonged to Kathiawad remained strangers to the land and the people of the country. They sympathised with nobody and nobody sympathised with them. They were considered as aliens and as such in their times of difficulties they could not look upon any Raja as their friend in distress. As Mahomadans they naturally looked upon the Sultans of Gujarat for support or help. They could stand against any of the chief states of Kathiawad. For in Zalawad, Dhrangadra, in Halar, Jamnagar, in Sorath the Babi Mussalmans of Junagadh, in Gohelwad

Bhavnagar were so powerful. The mussalman Sultan of Gujarat spared the Jats because they were Mahomedans for if they would have been Hindus they would have been ere long wiped out of Kathiawad.

As long as the Sultans were powerful, the Jats bade their time and they tried to study the actual circumstances in Kathiawad. They began to feel their way. They could not join any of the powerful party in Kathiawad so that began to study as to who were great disturbing elements in Kathiawad, who, by their joining hands with them may be able to be more than a match for any of these strong chiefs. They at once found that Kathis, Kolis, Mianas, and others were people with whom they began to cultivate friendship. As soon as the Sultans of Gujarat began to show signs of weakness the Jats joining with the Kathis and Kolis began to work a havoc in Kathiawad. They took to a cruel life of robbery and plundering.

They were very powerful in the last twenty-five years of the last century. They sacked villages, looted them, and put men mercilessly to sword. They made traffic impossible. Not only they robbed travellers but they took no pity over them even after robbing them of their possession they cruelly killed them. People trembled at their very name. The poor people were neither protected by their rulers nor their property was safe. This was the state of things in Kathiawad before the advent of the East India Company established peace and safety in Kathiawad.

The Jats joined hands with the Kolis and Mianas became notorious through the whole of Kathiawad. And when they were brought to bay by the Kathiawad Agency aided by the surrounding and interested states, the people of Kathiawad who had no sympathy with these people they turned their backs upon these people and the Jats sunk into insignificance and occupied the place for which they were fit in the province of Kathiawad.

Their names are just like Rajput names. They are such as Akheraj, Jasaji, Visaji, Lakhaji, Meruji, Manaji, Jemalji, Bhanji, Lakhdirji, Fullaji, Khengarji, Ranoji, Sumeraji, Lalji, Karsonji, Mulji, Sujaji, Gandaji, Jiwanji, Ratanji, Jasaji, Meghji, these are the names which remind us of Rajput names. But of late they are preferring Mahomadan names to Hindu names. They are such as Karimkhan, Bahadurkhan, Rahimkhan, Sultankhan, Bahauddin, Kamaluddin, Tejuddin, Ibrahim, Abubakar, Ussuph, Sahebkhani, Jiwan Khan.

The names of their women are Tejbai, Mulibai, Nagbai, Veerbai, Jivibai, Lakhibai, Rupbai, Janbai, Hajubai, Sonbai, Meghbai, Nanibai, Dosibai, Rambai, but now they have taken a fancy for Mahomadan names. These are such as Fatima, Hurbai, Rahima, Halifa, Nurbai, Karimma, Latifa, Salima.

Their surnames are derived from the villages or localities from which they come. There are many instances in other which men adopt surnames from the great men whom they consider the founders of their families, *e.g.*, if they consider Sadu as their great great grandfather they call themselves Sadhani, if they spring from the family of one called Khetaji they call themselves by the surname Khetani, if they consider Ladhu as their head of the family they adopt Ladhvani as their surname. Similarly if the founder of a great family happens to be called

Abaji or Meghaji their descendents call themselves Abani or Meghani. Thus we come across surnames such as Jasani, Bhimani, Hajiani, Surani, Hemani, Shamlani, Bhanani, Ratnani, Dudani, Haddani, Meghani, Unani, Hematani, Jesangani, Davani. From these surnames we can infer one thing and it is that they are very particular about showing their respect for their parents. At the same time they always cherish their memory by adopting surnames derived from their names. Any termination is generally found at the end of Sindhi names. It appears that Jats have passed through Sindh after living there for a long time and they testify to this fact by carrying with them the surnames with Sindhi terminations.

Jats came and settled in Mandal district. It is a district which has only twenty four villages. This district is situated on the northern coast line of Kathiawad. This small part of the land is situated just on the borderland of Gujarat and Kathiawad. They were under a great Mahomadan influence of the Sultans of Gujarat. Being strangers to Kathiawad Rajputs they were completely cut off from them and therefore they had no other go but to submit themselves to the Sultans, rule and their influence.

Birth rites. A Jat young wife is allowed or disallowed to go to her father's house for her first delivery. This is a question of the individual conveniences of the father of the young bride and the father of the young husband. If the father of the husband sees that there is no objection and there is every sort of convenience to both the families he allows the father of the young would-be-mother to go to her father's house at the time of delivery. He may not send her to her father's house if he thinks that it would be more convenient for the delivery at his own house. In general, it is a matter of mutual understanding. The young would-be-mother is generally made to go round her daily duties till before a month's time before the delivery time. Though it more or less depends on her general health. They do not require the services of a qualified doctor or a native physician. Their general physical build being strong it is not a painful delivery. It is very easy for a Jat young wife to get over maternity troubles and complications. The birth of a son is a matter of great rejoicings in the family and a birth of a daughter is almost of general sorrow and mental uneasiness. As the Jats are living side by side with the Hindus this mentality, have got this owing to the effects the influence of its Hindus. The good news of a birth of a son is at once despatched to the house of the parents of the father of the newly born child or if the young wife has not been sent to her father's house the news are sent to the house of her father. Generally as the custom prevails, the informer is given a small gift and given some 'Gud' to make his mouth sweet with.

No such time limit is fixed as it is fixed in certain more advanced communities for the lying-in young woman for which she is not allowed to attend to her household duties. She is allowed to take rest for some time and that time is indefinite. For as soon as the women of the household think that she is now all right and that she would be able to attend to her household duties without any wrong to her body or without any wrong to the little baby they allow her to join them in shouldering the responsibility and the burden of the household work.

In short, this depends on the financial position of the head of the family and the number of women actually living in the household. There is no hard and fast rule as to the allowing the rest to the wife who has just given a birth to a child. Namkaran on the sixth day of its birth namkaran ceremony is not celebrated. Of course not with any zest or great religious ceremony but quietly and calmly. Sweet dinner is prepared. The aunt of the infant and her family is invited to the dinner. The family Mullan is consulted as to what name should be given to the infant. Generally speaking, the names which are common in the family are some of the selected names out of which a particular fanciful name is selected. Dates and 'Gud' are distributed in the family and the relatives bless the new entrant in the family. The parents and grandparents are informed to this effect. The Jats do not believe in Vidhatri or the writer of eternal letters in the forehead of a six days old infant. They are free from this superstition. As soon as the child is a month or say a month and quarter old it is taken along by the woman relatives to some family saint or Peer for paying respects or for propitiating him by some offerings promised to him before the birth of the child by the parents or the grandparents for avoiding trouble and removing difficulties at the time of delivery. It is at the Durgah of the saint or Peer that coconuts are offered, dates and sugar distributed among the poor and the young children of the family. It is believed that the saint or the Peer blesses the child. Just at this time the maternal uncle or the maternal grandfather sends a frock, a cap and some silver ornaments for the child. He sends also or better he brings some sadi, petticoat, and a bodice for the sister and brings a turban as a present for the son-in-law. There is no hard and fast rule as to how much should be given to the daughter. Every thing depends on the financial position and the affection which one bears for the daughter or sister.

Education. In point of education the Jats are very backward. The total percentage of education is hardly 5%. A Jat boy has no other teacher in the world but his father. He is really speaking his guide, philosopher and friend. He picks up his first lessons from him and so also his last touches are received from him. He is his chief moulder of life. The child imitates his father in every respect. As soon as he is able to walk he follows his father and marks what he does. He becomes familiar with the implements of agriculture or arms to be used in depredatory excursions. He knows and he is taught their make, their use and the place from which they are to be had. Time works on and it depends on the child and his capacity to master his trade. If the father is a farmer the son takes interest in farming and follows him to the field. He takes care of the oxen, he looks after the cows and buffaloes. He goes to the river side to water these cattle, he feeds them and yokes oxen to the plough and such other duties he begins to do. He helps his father to take out water from the well and to water the plants with it. In the course of time he becomes a full-fledged farmer like his father and becomes a great helping hand and he shoulders half of his the responsibility. He helps his father to double his income and allows him to pay his attention to other serious questions which trouble him from time to time. If the father happens to be a marauder, which he is not at present he helps him in following his trade. He tries to fulfil his wishes and following in the same track becomes in course of time a similar or perhaps better robber or a cattle-thief.

These days with the awakening of the villages these Jats have begun to understand the utility of learning and with the encouragement of the native states the Jats have now begun to send their children to village schools and we find Jat children studying in schools when we pay visits to schools. Of course it looks very strange in these days that the Jats have not fully come under the western influence. The reason that may be attributed may be that they are living far away in the interior of a province like Kathiawad. But it is quite clear that they will in the course of time join with other communities in a race of advancement. Girls as soon as they are able to walk and understand, they follow their mothers and they slowly and slowly try to be helpful to their mothers and other elderly women of the household. They pick up household work like that of sweeping the rooms and court-yard. They learn how to look after the household cattle, to keep clear the yard in which they are tied. They feed the cattle and make cow-dung cakes, cleanse the utensils and as they grow old learn a bit of sewing too, in short, they work as household assistants to their mothers or sisters or any other elderly women in the family. In the course of time, they become fully developed women beautiful to look at and admire. They become worthy brides for the bold and brave Jats. And as young Jat boys develop a fine physique, a robust health and a fine handsome appearance so also Jat girls grow into beautiful women. Jat boys learnt the art of war some fifty years back but now they are being made meek and docile by the force of circumstances. They have taken to peaceful avocations and settled down as cultivators. We can see from the study of the Jats and other backward communities that if these people remained aloof from the schools and colleges they managed to make brave and hardy men just equal to the time in which they had to live. They learnt all that they were expected to learn by the society in which they lived. They did not learn the modern ways of the world however they did not also unlearn the things which were most essential for them to learn.

'Sunnat-Sadi.'—As soon as the boy is eight or ten the father and the mother or say the grand father if he is alive, begin to think as to when they should celebrate his Sunnat-Sadi. They accordingly consult the family Mullan (Priest) and according to his advice they fix a suitable date. They call the family barber and ask him to perform the petty operation. He does it and he is paid a pound and a quarter of wheat and five annas with some molasses. The sum five annas may sometimes, in certain cases be raised to a rupee and a quarter. But this depends on the choice of the father and his power of the purse. The boy is not allowed to be out of his bed for a week. He is confined to his bed and people are not allowed to pay him visits. They are of the opinion that there are certain evil eyes from whom they should guard him. It often happens that the healing takes a long time and sometimes troubles are created. It is therefore they tie nim tree leaves on the threshold of the room and also of the main door of the house. The boy is well fed and kept pleased. As soon as the wound has been healed the father of the boy and even before that the father thinks it is his duty to satisfy every wish of the boy by purchasing petty things that he asks him to purchase for him to suit his purse. The sumptuous food is given to the boy with the idea that if he is kept pleased the wound may be soon healed. Again

the occasion is considered as good as *sadi* or marriage occasion. Sweet food is cooked and the family members partake of it in a jubilant mood. The father writes letters of invitation to his family members living in distant villages. He also invites his friends to go to attend the 'Sunnat-Sadi' ceremony which he intends to celebrate on a particular day which has been fixed. It is a custom that the relatives who are invited go to the house of the father and join the family in celebrations of 'Sunnat-Sadi.' Rich feasts are arranged for the guests and they all jubilantly partake of the feast. The boy whose 'Sunnat-Sadi' is celebrated is taken round the town or the village in which he is living in the streets in a procession with drums and tabors played before him after the wound is healed up, with the party richly dressed and the women folk all singing songs. At this time the friends and the relatives keep the procession standing near their houses and offer certain gifts to the boy. This gift is nothing but a pound and a quarter of wheat with molasses and a sum of five annas to a rupee and a quarter. This ceremony is undergone at some three or four places. The father of the boy spends some three to four hundred rupees. It depends on his financial condition. Of course, there are instances in which a father spends say, two hundred rupees and in certain cases he spends a thousand rupees. We cannot but take a note of one good custom and it is that the relatives who are invited make it a point to give a rupee at least sometimes ten or twenty rupees by the way of help to the father because, he has followed the prevalent custom. This is a custom that goes a great way in helping the father who has spent so much to entertain his relatives and friends. The father and the mother of the boy generally speaking, gives him more than others do. They give him a full pair of clothes of course costly ones. The same way they present the mother with a full pair of costly dress. They do not forget the boy in question. We can here compare this 'Sunnat-Sadi' ceremony with 'Yagnopawit' ceremony of the Brahmins. The maternal family of the boy to whom 'Yagnopawit' is given has to offer or to bring, *Mamera*, for the boy. In the same way the relatives offer their 'Hathgharnas.' This is meant to help the host to meet the expenses he has incurred.

As soon as the feast is over the relatives and the friends of the host begin to take his leave and praise him and thank him for what he has done for them. In this way the 'Sunnat-Sadi' ceremony is celebrated, among the feasts and festivities. It is in short family celebration attended by family members and other relatives.

Betrothal. When boys or girls reach a marriageable age the parents think of getting them betrothed. The relatives take an important part in this matter. When they learn of the intentions of the parents they begin to look about for a suitable match. Generally speaking, the paternal aunt always tries to see that her niece is offered in marriage to her son. She thinks that it is her right and her right only to get that gift from her brother. She often becomes successful. Of course there are cases in which a father of a young daughter chooses some other suitable husband for her daughter. To this his sister does raise an objection and she thinks that her right has been overlooked. In certain cases, there is a breach of relationship between the brother and a sister on this point but if the brother is tactful he patches up the breach. When the father and the mother of young girl decide to

offer their daughter to a particular boy, they inquire into his parentage, his status, age, appearance, his relations rich or poor and after consulting their relatives decide to offer their daughter in marriage. At this stage they declare this betrothal by calling the leaders of the community who are considered wise and prudent. These people form a 'Jamāt.' They meet in a place called Jamātkhana. Here the parents of the would-be-bride declare that they offer their daughter to a particular young man, the son of so-and-so in marriage. Gud and Dhana are distributed. Sometimes dates are also distributed to sweeten the mouths of the people of the community. There are some people who being rich feed the poor people and the fakirs.

The marriage date is fixed according to the convenience of the parents of the would-be-bride and the would-be-bridegroom. The information to this effect is sent to the father of the bridegroom. He in turn sends this information to his relatives. Before the marriage date is fixed the Vevais i.e. the father of the bride and the father of the bridegroom decide as to how much money is the father of the bridegroom to pay to the father of the bride for the daughter that he has offered in marriage. This is called the marriage-money. Generally speaking, this money is that is agreed upon is rupees two hundred to three hundred. But now-a-days this sum has been very much reduced. It has been brought to rupees hundred to one hundred and fifty rupees. A general principle is being excepted that lesser the money is expected, better for the father of the bride. Accordingly, it is also settled as to how many men are to be taken by the father of the bridegroom as a 'Jan' or the marriage party. He cannot according to the rules and regulations of the community, he cannot take with him more men in the marriage party. Daughters are offered wherever in whatever family of the community one likes. When the marriage date approaches the father of the bridegroom begins to make preparations for the marriage. He begins to purchase food stuff, good clothes to be offered to the bride, he also gets new clothes sewn for the members of the family especially for himself and his wife, his parents if they are living and his own other children. He goes to the goldsmith and purchases gold and silver ornaments for the young bride. In short, he spends what he has spared in the past few years. So does the father of the bride, for he has to entertain the bridegroom's party. He also has to buy food stuff in large quantity, clothes and some silver ornaments for his daughter.

'Mandaparopana' ceremony is performed and the women of the family sing songs, sweet dinner is prepared and the relatives are invited to it. The Mandap or the marriage booth is decorated according to the affluence of the father of the bride. However he sees that it is made as fine as possible. The marriage party starts on a journey, if the father of the bridegroom is living in some other town or village, say a day earlier to reach the place in time. But if he lives in the same village he has not to go on a journey some time previously. In that case the father of the bridegroom has his own house and the father of the bride has not to take any trouble for providing a suitable 'Uttara' for the marriage party. But if the marriage party comes from some other village the father of the bride has to provide him with a suitable dwelling place where the party may come and stay for the marriage occasion.

He gets earthen pots bought from a local potter and gets them filled with water for drinking purposes. He has to engage some servants to look after the conveniences of the marriage party.

In case the party comes from some other village 'samaiya' or reception is offered to the party when the father of the bride accompanied by his relatives go to the outskirts of the village and receive them and accompany the party to the Uttara with drums and pipes played in front of them. There they are made to be at ease.

In the meantime the preparations for dinner are being made by the relatives of the father of the bride. When the dinner is ready the marriage party along with the bridegroom is invited to dinner. There the party does full justice to the dinner. After the dinner is over the party leaves for their resting place and the bridegroom is made ready for going to the house of the bride for 'Niccāh.' He is sumptuously and tastefully dressed. He puts on a 'surwal,' a frock coat, he winds round his waist a rich cloth. He puts on a Jat turban tastefully and puts on a 'sherra.' A sherra is nothing but a face covering generally made to order of flowers of the season. If they are not available this 'sherra' is made of pearls. These strings are nicely knit. They hang on and about the face of the bridegroom and it is believed that this sherra not only enhances the handsomeness of the bridegroom but it throws a kind of spell around his face and features. They believe in evil eyes and therefore this decoration is used to ward off evil eyes. This custom is generally found in Bohras, Sepahis, Memons and many other musalman communities. This 'sherra' is made to order and a bridegroom does not get on his horse back and starts for the marriage celebration without this 'sherra.' In short it is a necessary ornament which must be worn by a bridegroom. The procession is preceded by drums, tabor and pipe men who play beautiful tunes while the party goes slowly and with due pomp and display of the so called wealth the bridegroom people possess. When the party reaches the house of the bride, the bridegroom is received by the men and women of the bride's party. The bridegroom is taken in with due respects and decorum surrounded by the women folk of his side and the bride's side. He is made to sit on a special soft seat especially made to order for him. While other men of his party are seated on soft seats. The women of course go in the inside of the house where the bride is made to sit fully decked and decorated by her people. They are received by the women folk of the bride's party. They join other women who are singing songs.

In the meantime the Mullan is already sent for and he is waiting for the arrival of the bridegroom. He is ready to perform 'Niccāh' ceremony. The father of the bridegroom had already paid the sum of money settled previously by him with the father of the bride. So there remains nothing important to be done by him or his party. But in case this payment business is not done due to some unavoidable reason he makes haste to pay up the settled sum to the father of the bride. It is a general custom that the ceremony is not performed unless and until this payment is made by the father of the bridegroom. Often serious and grave things happen and if the matter is not tactfully handled by the wise men of the family or the Jamat the 'niccāh' ceremony is not performed for the relations are at once strained. But

such things seldom happen. And if they happen the headmen of the caste or the so called Jamat intervenes and brings about a workable compromise. Some body stands as a surity and the ceremony is performed with due rights.

Now the bride remains sitting inside the house. She does not come out to have a look at the bridegroom or does not offer her hand in marriage as the brides do in other communities. So one man from the bridegroom's side and one from the bride's side is appointed as *vakil* and a *sahed* i.e. witness. These gentlemen are sent by the Mullan to the bride sitting in the house surrounded by women folk. They go and ask her if she is willing to marry so-and-so the son of Mr. so-and-so. To this question she replies in affirmative the men who are sitting there take a note as well as the 'vakil' and the 'sahed' who have gone to the bride take a note and after doing so they go out and signify her consent and approval to the Mullanji and so this being done to Mullan reads Kalma prayers and blesses the new couple. The whole ceremony does not take more than an hour at the most. If the Mullan is quick he can complete the whole ceremony in less than forty five minutes. When the ceremony is going on the women folk on both the sides go on singing songs the main purport of those songs is the greatness and the nobility of their own people and the littleness of the opposite side. They also sing Phatanas i.e. the songs which are full of abject jokes and ridicules and abusive language. The people do not take this as an insult or they do not take it ill. They are given dates and sugar or molasses. They are offered betel nuts and nut crackers and they freely partake of these things. When the whole ceremony is over the party starts for the resting house or if the bridal party is a local party it goes to its house. They take the bride with them for say half an hour to accompany the party. But after that time they send the bride back to her father's house. No dinner is served at this time because it is high time for the people to retire because it is about mid-night.

Next day early in the morning the father of the bride goes to the father of the bridegroom and if he is very busy in making preparations for entertainment of the guests he sends some to look after the conveniences of the bridal party. He considers it to be his duty to see that the party is not only thoroughly entertained but it is fully satisfied.

That day a sweet dinner is given to the party. And in that the principal men are pressed to take as much quantity of sweetmeat as they possible can. Of course, everything goes on very agreeably and joyfully. Sweet jokes are cut and the whole party is in a extra happy mood. As soon as the dinner is over the preparations are made for the sending of the bride to her father-in-law's house. The father of the bride has collected and duly arranged in a room of his house the articles and things which he means to offer to his daughter. These things contain every sort of household material, clothes and many other gifts, he is able to offer to his daughter. The people of the town especially the members of the community pay a visit, as a matter of fact, to the house of the bride and look at these things making agreeable remarks praising the father of the bride for offering so many presents in the hard times, this is done out of courtesy. When all the members expected have paid their visits the whole show is wound up and sent with the daughter as she starts for her father-in-law's house.

It is generally in the evening that the marriage party starts. The clothes and the ornaments of the bride are arranged and packed by her mother and her sisters and brothers' wives if any. She is dressed in her best attire. In the evening the bridegroom's father sends a word that they are ready to start for their home and that the bride must be made ready. Accordingly, she is made ready and sent with some women folk of the bridegroom's party in which there is some responsible woman such as the mother of the bridegroom or his elder sister or his sister-in-law. Then accompanied by her own mother, sister and other relatives the bride starts for the house of her husband. The women of the bridegroom's party are all as jubilant as ever and the women of her side seem depressed in spirits because they are parting with their dear and near relative.

When the party starts for the house of the bridegroom women sing their songs and the mother and the sisters of the bride shed tears due to the pang of separation. Generally speaking, the relatives of the bride go up to the outskirts of the village to bid her farewell, and with sorry faces return to their houses.

Divorce. Marriage contract in Jats is not insoluble. If the woman or man is of bad character, or given to incurable ways, wanting in affection, if he is a man of cruel nature, divorce is but natural. In that case either of the party approaches the 'Jamat' through the parents, if the parents have died, they approach the Jamat through some near relative. The Jamat calls a meeting and hears the parties. The Jamat decides the question by allowing the wronged party to break the marriage contract they allow the wronged party a sanction called Talaq by which she or he can sever all the matrimonial relations. And each one of the party is allowed to seek a fresh match. The 'Jamat' charges the man who calls the meeting a rupee and a quarter. This sum goes to the poor fund of the community. Divorces are not incidents of every day occurrence.

The marriage and after. After the young bride is sent to her father-in-law's house, she is well treated and sweetmeats are prepared in her honour. She is not asked to join the other ladies in the household work. She is for the time being made to sit and see things and the customs and ways of the people of the household studying, if she is capable of studying the natures of the members of the family. She enjoys the happy life in the house where she is to live and die by entering into the dust of the soil. After say fifteen days, her brother or her cousin is sent by her father to take her back to her father's house. He comes and is well received by the family of the bridegroom. Sweet dinner is prepared in his honour and the bride is sent with him on the day appointed by the bridegroom's father. She goes to the house of her father a stranger now, in the house for she belongs to the house of others. She stays there for a few days when the mother does her best to please her daughter by all possible means in her power. She is sent back to her husband's house on the fixed day, fixed by the bridegroom's father or in his absence the elder brother of the young husband. Now she stays at her husband's house for a pretty long time.

In the mean time she being aged enough begins to carry and as said before stays at her husband's house or goes to her father's house

to give birth to her first child. From time to time, the father or the brother of the young wife does not fail to write letters informing her of the news at home and any important happening that has occurred at home. They do not forget to send small gifts such as of eatables, dress, and many other sundry things that she requires during her stay at the house of her father-in-law. Sometimes they send or ask some one going to her village to go to her and ask her if she is all right. These people give her some gifts. They may be in the form of money or other gifts such as of clothes or things of daily necessity.

Funeral rites. When a Jat falls ill, he is looked after by his relatives and friends. They try to help him by giving him every sort of help by the way of calling in a doctor or a local physician, if available. There is a good fellow feeling to be found in the Jats. They are always ready to help one another in the time of distress and difficulties. When they come to know that the patient is about to pass away they at once inform the Mulla who at once goes to the house of the dying and says prayers to free him from the troubles he is passing through.

As soon as he dies the men in the community are informed of the incident, along with the relatives living far from the place of the residence of the dead. A man is sent to the graveyard to inform the man in charge of the graveyard that such and such man has expired and that the grave diggers should be immediately called and ordered to dig a grave for the dead. Just at this time, some one of relatives goes to the Jamatkhana or to fetch the bier called 'Jannaja'. Some relatives are sent to the bazar to buy the long cloth for the dead person to be wound into. All these things are at once brought and his relatives and friends gather together from all quarters to pay their last respects to the dead. The dead body is bathed with cold water and made clean after which the 'Jannaja' is brought in the room in which the dead body is lying. A soft quilt like or cushion like bed is placed in the 'Jannaja' and on that the dead body wound up in the long cloth say thirty two yards very respectfully placed in it. All in the house extremely quiet and full of grief and sorrow. There are some in the house who shed tears but shedding of tears is disallowed by the religion. But who can prevail against the sincerest feelings of the heart. The party *i.e.* the funeral party starts from the house of the dead and a man proceed the party with a incense carrier in which a fire is burning and Loban incense is spread on the fire. The mullan is very seriously going along the road reading the Holy Text. The mourners go on saying "La Alla Ill Alla Mahamad Rasul All Allah." The road is slowly passed through and the party soon reaches the burial ground.

In the burial ground the grave is made ready and when the 'Jannaja' is placed by its side the Mulla reads prayer from the Koran and the funeral party hears the prayer with their heads down on account of grief. The dead body is lifted from the Jannaja and placed in the grave by the relatives and the Mullahji helps them in doing so. After this ceremony the nearest relative present there throws the dust lying there on the dead body and then the others who have gone as mourners do their bit by throwing dust in the grave. In a short time the grave is covered up. The Mulla then says a prayer there by requesting the Almighty to give the departed the rest he deserves.

The funeral party after this ceremony returns homeward. When the party reaches the street or the lane in which the house of the departed relative is situated the relatives headed by the Mulla stand in two rows where the Mulla says a prayer called 'Phatia' after this prayer is said the relatives and the mourners who had gone to the burial ground disperse. The nearest relatives go on accompany the nearest relative even up to the house in which he lives.

There is a very good custom in Jats and it is that all the relatives dine at the house of the person dead for at least four days. Of course if the person is not rich they understanding his pecuniary position help him indirectly by taking their own home-prepared food to his house and dine together. The underlying meaning of all this is to give him company and to share his sorrow and the grief. For it is a well-known fact that when a man is in grief or in sorrow he should not be allowed to live alone, for in that case his mind will think and think about same thing and the consequence of it may be in many cases that the man in grief may be attached by melancholia or a madness. They dine together and there are some of the relatives who sleep by the side of the man in sorrow. This is only done for a few days. After the man is accustomed to the sorrow a little, the relatives of the person who have lost a dear relative is left alone, but not quite abruptly.

As the usual custom goes the head of the family who has lost a dear relative orders masons to build a grave after the burial ceremony is over. For this the mason give their bill to the gentleman and he pays up the bill.

The Jats like Rajputs mourn for the death of a relative for one complete year. They put on a mourning dress the women especially put on black sadi. They keep their faces hidden under their 'Veil.' They generally do not go out in the bazar or to any other relatives' house to pay a visit. They eat coarse food and do not prepare sweet-meats. So do men. They generally put on white turban and do not take any part in rejoicings at any relatives' place or do not take part in any marriage they also do not get married their daughter or sister for one full year. They do not enjoy rich and sweet food and avoid festivities. But the course of time has brought about its own changes and it is due to that these rigorous changes of custom are getting looser and looser to the result that these people do not observe mourning as hard and fast as they did fifty years ago.

On the fourth day after the death of a man a religious ceremony is performed in which the poor and the destitute musalmans are fed by the head of the family in whose family the death has occurred. It is beleived that by feeding and clothing the poor and the children the spirit of the dead experiences a sort of satisfaction and happiness. His clothes are given away in charity to the family priest or mulla. Even the shoes and the stick, the umbrella and every sort of petty belonging is given as a religious gift to the Mulla with the understanding that these things will be given to departed in the other world.

On the tenth day a Dasaiyun is the tenth day is observed. On that day a sweet food is prepared and distributed amongst the poor and the fakirs. The young children of family in which the death has occurred are also fed.

On the fortieth day, the same sort of ceremony is performed when the Mulla offers prayers for the peace to the soul of the departed. The poor and the children are fed. After this ceremony every year on the Tabut day the relatives of the person dead, pay a visit to the tomb or that dead relative and if they can afford, get it whitewashed. They cover it with a cloth, burn incense and praying for the soul of the departed, return home. This is done after the Tabuts are taken to their final destination. If the relatives are not well to do they simply pay a visit to the grave of the dead relative and offer their mental prayers remembering his other obligations or good deeds he or she may have done to the members of the family. They do not forget to ignite a lamp and offer loban incense.

Religion. Jats are Sunni musalmans. As such they offer five times prayers. They observe the Ramjan fasts and Idds as other musalmans do. They are as zealous and orthodox musalmans as any other musalmans. The reason is that they have been converted for the few centuries. Slowly and slowly the religious fervour is seen in them.

Fairs. They have their own religious fairs. There have been certain great 'Peers' or saints who have placed the Jats under great obligation and it is therefore that they remember them by gathering about their birth-places and sometimes about the places where they have expired. Such fairs are held near Gotarka Peer's durgah. This Gotarka is six miles east towards Varahi. This Peer is considered to be a great Peer and the Jats in thousands gather together round his Durgah on the day on which he expired. A similar fair is held in honour of Mahabali Peer near his durgah. There are many Jats who have a great faith in this Peer. It is believed that this Peer helped the Jats in their predatory warfare. As soon as the Jats remembered him while fighting, the Peer used to appear before them and help them on to their success. There was a time when the Jats used to keep with them a 'Neja' of this Mahabali Peer while they started on their excursions. This Peer's durgah is situated near Randhanpur. There are other fairs held in honour of Hublishah, Gulam Shah, Ruknuddin Shah and so on. These fairs have a double meaning. The first is that the Jats repair to the Durgah of these saints, offer their respects to them remember them for the great obligations done by them to the Jats in times of difficulties. They gather there, offer prayers meet people increase the social contact, eat and drink together perform a sort of religious pilgrimage. In short, these fairs have a great religious, social, moral and ethical value. On these days the Durgahs are whitewashed the poor musalmans and the fakirs are fed, the poor are clothed so the people have good opportunities to do whatever they can do to others out of religious feelings.

Dress. The Jats put on 'surwal' or a close breeches with a button made of cloth to fasten the lowest part of that 'surwal.' They put on a 'Bheth' or a piece of cloth tied round the waist in a rather picturesque manner. Though the usual way of fastening this 'Bheth' is common but each man can add personal touches to it. They put on a country shirt or 'Bündi' with a number of button laces—strings made up of the same kind of cloth of which the 'Bündi' is made. Just around the chest it is very fitting. They put on a double Morbi type turban which becomes them very well for they wear good moustaches and beards. Any one who looks at a Jat will at once be reminded of a Rajput in dress, in type of the dress, the general career and some of the peculiarities

which the Jats have adopted or kept up upto this time. These peculiarities are the general outlook of the dress, their cut, the moustaches etc. Now the time is changing fast and the Jats' ways of putting on their dress has suffered a change. Now they are adopting the musalman way of putting on a 'Jangha' or a loose pantaloon, half coat and a turkey cap. We can at once tell one by looking at a Jat that is he more of a musalman than a Hindu. The Hindu peculiarities are fast being abandoned and musalman peculiarities are fast occupying an importance in their dress and manners. Jat women have not undergone a change so far as their dress is concerned. They put on a Sadi in a Rajput fashion. They put on a petticoat and a close fitting bodice with no buttons but cotton strings to be tied up at their backs. However, they are now putting on this Sadi in a musalman fashion. In the dress of the boys and girls no peculiar change has been noticed. The thing is that the Jats are economically poor people and therefore they cannot afford to make or introduce any great change in their dress or their general manners. The Jats cling on still to their old ways.

Ornaments. So far as ornaments are concerned the Jats generally do not put on any ornaments. However, we find them putting on a ring on their finger. Very few put on any necklace. But women put on various types of ornaments. They put on a gold necklace if they can afford, otherwise silver necklace. They put on bangles, nose rings and ear-rings in their ears. When the Jats were well-to-do they used to get these ornaments prepared from pure gold but now as they are every day getting reduced to general poverty, they get these ornaments prepared of silver. Now we find that the Jat women put on ornaments on only marriage occasions or on any other occasion in the family. There is a musalman touch in these ornaments i.e. the ornaments are just like ornaments which muslimans put on. One thing must be taken into consideration then getting ornaments for a daughter or a son's wife depends more or less on the affluence of the person concerned. But as the mass is daily and daily getting poorer and poorer the custom of giving and expecting ornaments from the father of the bride is getting out of vogue.

Life of a Jat. Jat is primarily a cattle-thief or a carrier and secondarily a farmer. For about a period of three centuries Jat used to roam about the northern part of Kathiawad fully armed. They used to go without any trace of fear even in the heart of Kathiawad. Befriending with the turbulent Kathis, Kolis and Girasias who used to take to outlawry they used to make themselves fit on poor population of Kathiawad. Wherever there was a struggle or a fight or a sort of internal fight these Jats like jackals were bound to be present. They used to eke out their lion share or otherwise, as the time and circumstances allowed. They were extraordinary clever in stealing away cattle of whomsoever they could lay their hands on. They show to the people at large that they are cattle dealers. They steal away cattle and taking them to Gujarat they sell them. It is said that they used to steal cattle and change their features by applying oil or shortening tails or cutting off their horns if possible. Being full of arms and ammunition they were always ready to fight against any odds and maintain their point.

They used to hide cattle in such a way that even the best spies could not find them. They used to have such houses which had more than one

entrances and exit. Sometimes, they used to pass the cattle from underground ways only known to them. It was very difficult to distinguish ones' cattle from their cattle once they were stolen. Living on the borderland of Kathiawad, they found it was very easy to despatch the stolen cattle from one place to another. One thing more in their favour was that Kathiawad was in a very unsettled condition. It was very difficult to curb them or to stop them from their notorious practices. They took the fullest advantage of this disorder. But as the E. I. Company stepped in Kathiawad with law and order and established peace, these depredations of the Jats were effectively curbed and put a stop to. They found that Kathiawad was a hot bed for them and therefore they took to peaceful occupations like cultivating land and maintaining themselves by labour. However, one is not so safe in Jatwad as he can be in other states. There is every possibility of one's coming across a Jat band, out for robbing people going on foot through their province which will surely rob the stranger. Strange to say that there is no railway train passing through-Jatwad. One has either to travel on foot or in a cart drawn by oxen or on horse back or if possible by some other vehicle. As said above the Jats have now settled down to peaceful occupations. We find them today cultivating their land. The land they cultivate belongs to some state, and they work on the field paying the fixed part from the produce to the owner of the land or the state whose land they cultivate. Jats still deal in cattle. They go to Gujarat, Cutch and sometimes upto Sindh with their choice cattle and sell them. In the meantime if they come across any bulls, oxen or camel or a horse of any one which they can take away they will be the last not to try it and take it away successfully. The reason is quite simple and it is that they have not quite forgotten who they were or their old ways. Jats are good riders and one of our Gujarati poets Kavi Dalpatram while requesting India to thank God, mentions that Kathiawad was infested by stalwart Kathis, and the bands of Jats and their horses used to stop travellers while they were travelling.* These have disappeared he says and for that India should rejoice and thank God for that. In short Jats were notorious outlaws, cattle robbers throughout Kathiawad. It is good that they have settled down to peaceful avocations. However one thing should be marked they are not so assiduous on their fields as they were on the land routes leading to Gujarat, Cutch and Sindh.

Nowadays their life is a life of an ordinary farmer. They look after their cattle and fields. Growing different crops from time to time. Unfortunately, for them the Zalawad is not so fertile as Sorath and therefore, all their labour and pains do not bear the expected fruits. The States, however, look pathetically towards them and with great difficulty they make two ends meet in these hard times. They go to the fields, cultivate them and get whatever they can produce from them. We can say that these Jats are not some of the most assiduous farmers of Kathiawad. We can say that Kunbis, Mumnas, Satwaras, Patidars in some parts of land bordering Gujarat, are some of the cultivators with whom Jats cultivators cannot compete. And what is worse is that their old trait does not leave them. Economically Jats are worse than other cultivators. So what happens is that the Jats give up agriculture for that does not afford them any attractions. They take to petty jobs

* “ધિંગા કાડી જતનાં ધાડાં ઘેરાં ઘેરી ન શકે વાટ.”

in states and if they cannot get or acquire them they go in for labour of any type. What they aim at is daily wages. That is what they think can help to live well. We find Jats in police service and other petty services. There are some who have gone along the northern coast of Kathiawad with their camels grazing them on the coast line where they have a special facility.

In the sea there grows vegetation which is constantly found in the tide water. That vegetation is called 'Cheriah.' Camels like this and satisfy their hunger very well. So these Jats have not to pay at all for their fodder for their camels and they live on camels milk. They sell the surplus that they do not want. Thus not only they can maintain on these camels but they get what additional money they require for their daily necessities. From these camels' hair they make ropes or any other saleable articles, and they sell their camels when they find that the number had increased and the number is greater than they can easily look after. • These Jats are found wandering upto Sikka, Sarmat near Jamnagar and sometimes upto Bet and Dwarka. We can say that Jats have a great fondness for cattle as Rabaris have, but the difference between them is that Rabaris are peace-loving religiously bout people while the Jats are strife-loving and a bit agnostic in their notions. Jats are hard pressed by the present-day difficulties and hardships as all other classes of people of the province, but the difference lies between other castes and the Jats have no other occupations to fall back upon. Naturally too, Jats are physically or mentally not so equipped to push their way in other fields of life. Their criminality has come in their way it has marred their progress in other fields of life. Jats like Mianas and Kolis were of a bout criminal of mind. They lived more or less by robbery, decoity and burning villages and looting them whenever they could effectively do so. Either alone that is to say unaided by any one or when it was not possible to fall upon any village singly they used to take with them Kolis, Mianas, Kathis or whomsoever they could befriend themselves for the time being. They used to rob parties of travellers on way to some holy place in Gujarat or Kathiawad. As the Mianas, Waghers and other such communities can boast of certain robbers and dacoits and gangway robbers so also Jats can boast of such great robbers. Bhimo Jat, the terror of the whole of Kathiawad was one of these Jats. They broke open jails big and small and they used to make bold escape from them in a skilful way or we can say in a miraculous way. Even the police officers of the surrounding states of Kathiawad bear witness to the fact that these Jats were a great scourge to the whole of Kathiawad.

Even today in these days of all Kathiawad it is considered unsafe to pass through Jatwad without a good protection. For they are always on a look out to rob any one if opportunity offers itself. Cattle too are not safe for one knows not when they may be driven away from the pastures against all opposition of the shepherds or the masters of the cattle. Their living on the boundaries of different states and the Government owned districts give them the greatest possible facilities for they can very easily pass from one jurisdiction to the jurisdiction of some other state or the British jurisdiction. It is very difficult to stop them or to arrest them. They in the meantime dispose off the property they have so notoriously acquired. Of course we must admit that they are not so active as they were years ago.

Food. The Jats being Mahomedans are meat eaters. They take wine but the pecuniary circumstances do not allow them to be meat eaters. They are too poor to indulge in this luxury. However, on holidays and such other rare days they do take meat. Ordinarily they are used to take bread and vegetables, pulses and rice, butter and milk if they can afford.

Jat Traits. Jats are generally speaking tall and stalwart as men. They wear moustaches and wear beards. Thus they look like Rajputs. By nature they are clever, cunning and crafty people. It is very difficult to mislead them or misguide them. They have a deep insight in the art of weapons. They are clever enough to mark the times in which they have to live and the men with whom they have to deal. They are more wily than bold and always try their best to carp out their own interest at any cost. It is due to this nature that they have some small principalities in Kathiawad and Northern Gujarat. In Kathiawad they have their own Jatwad. This is very significant.

Heritance. In point of heritance a Jat woman who prefers to marry someone else after the death of her husband renounces all her claims to the property of her dead husband. Often her children are taken away from her when she takes to some other husband. For it is quite natural that all her affections and maternal love leaves her heart as soon as she marries some other husband. It signifies that her choice of other husband shows her preference to children. But there are some instances though very rare in which widows out of sheer love or affection for the dead husband does not wish to marry again though allowed by the custom prevalent in the community. In this case she remains the sole owner of her husband's property. There are no other claimants. She remains the mistress of the property. She looks after the management of the household and takes the necessary precaution to do so. In the point of language the Jats speak Gujarati language but there is a little admixture of Urdu language. There are a number of Urdu words in the language which they speak. They also speak our Gujarati language in a peculiar way in which our musalman brethren speak. Especially their songs are very much tinged with Urdu words. However they speak and write just as we do.

Conclusion. In short this community which was once a cause of fear to the whole of Kathiawad has been reduced to a pitiable condition. For no one has cared for the people, no one has cared to look after their education or well-being. On the contrary, they have been discarded by those with whom they have lived for such a long time. Education as such, has been denied to them and they have fallen prey to the consequent evils both social and moral. We have nothing but a tear for them who are neglected and uncared for. They have allowed themselves to degenerate and deteriorate. The so called society has made it quite convenient to stand and see to what length and to what depth these people fall. We cannot but say that if these Jats would have been educated and well-looked after, they would have surely contributed their best to the province of Kathiawad. Let us hope that in these on coming bright and prosperous days of awakening they will rise to the occasion, brush off the old and century old dust from off their bodies and clothes rub their eyes look around and join in the onward march towards peace and prosperity.*

* I am sincerely thankful to the University of Bombay for giving me financial help to carry on this piece of research.

1

A song sung by the women of the bride's party.

There are eight wells and nine stepped wells.
 Rupbai goes to fetch water
 Haloji see her and is enchanted
 His mind dances as dances a creeper in the gales of wind.
 He goes home and does not eat or drink.
 His mother asks him the reason of his moodiness.
 He does not answer at first, but at last
 Says celebrate my marriage with Rupbai
 If you care for me.
 She reports this to her father-in-law
 And the father hurries to request
 Rupbai's father and arranges to get Rupbai's hand in marriage.

2

A song sung by the women of the bridegroom's party when the mother of the bride goes to the door to honour and welcome the bridegroom.

Slowly, oh, slowly receive the bridegroom,
 In thy house oh, mother, of the bride !
 Preserve thy pestle for you will require it afterwards.
 Receive the bridegroom mildly oh, mother of the bride,
 Preserve thy 'Trak' (spindle) for you will require it surely.
 Receive the bridegroom slowly
 Preserve thy churning handle for you will require it surely.
 You will surely require them for pounding, spinning
 And churning thy curdled milk.
 Slowly, oh, slowly receive the bridegroom
 In thy house oh, mother of the bride !

A song sung by the women of the bride's side.

We have a 'Manchi' a sitting stool made of ivory
 There sits Sonbai the beautiful
 A desire for marriage sprouts up in her heart
 As does a mango blossom in spring
 She requests her grandfather
 Oh dear grandfather, find out a fine brave fellow
 For me and celebrate my marriage with him.
 The grandfather smiles and takes her by his side.
 He promises and finds out a fine young fellow
 That pleases the dear fond Sonbai.

A song sung by the women of the bride's side (a phatana).

Observe well the handsomeness of the bridegroom
 Oh women and laugh under your sleeves.
 He is blind by one eye and squint by the other,
 Observe him well.
 He has not one ear and the other ear is half cut
 Observe him well.
 He has not got one nostril and the other is of no use.
 Observe him well.
 He has no hair on one of his temples and the other is bald
 Observe him well.
 He is helpless from birth and his feet useless
 Observe him well,

A song sung by the women of bridegroom's side.

We have acquired a great victory over Abharambhai.
 We have acquired a great victory over Abharambhai.
 Poor fellow has been forced to give up his daughter
 A daughter like a gem of his eyes. A daughter like the Sun of his eyes.
 Completely defeated is the father of Sonbai.
 He stands with his hands folded before the grandfather
 The grandfather of Usufbhai the bridegroom.
 Jusuphbhai takes pity on him. He recommends him
 Recommends him to his great grandfather.
 He gives him his life back on his offering Sonbai.
 Sonbai the light of his life. The gem of his household.

A song sung by the women of the bridegroom's party when the party is about to start for the house of the bridegroom.

Send Veerbai to her husband's house
 Send her with us she belongs to our family.
 We have won her over from you.
 She is yours no more.
 Send her on with us the drums are beaten
 Hear the shrill impatient Pipe.
 Hear the bells tied round the necks of the oxen.
 The oxen yoked to the chariot brought specially by us
 To take Veerbai with us.
 Send her with all her presents and 'Purats.'
 We are all impatient and can brook no delay.
 Let her forget her old surroundings
 Send Veerbai to her husband's house and bless her
 Bless her that she may live and enjoy her life.

A song sung by the women of the bridegroom's side.

We have taken, we have won over the bride.
 Her mother is a idle wretch she is a fool
 She had gone to look after cattle
 We went to see the beautiful bride
 And carried her away.
 The mother remained weeping in the house.
 We have taken away the bride. She belongs to us
 No more, no more, of her mother's.

A song sung by the women when a new son is born in the family.

You, you live long the dearest son.
 Our chief source of joy and delight.
 Long live you our furtherance of the line
 Our source of hope and our chief happiness.
 You are more beautiful than any son of god.
 You with your black jet like hair
 Curly flowing hair.
 You with your beautiful eyes, ears and face.
 Live long you are the blessing incarnate of God.
 May you live long and flourish.

A song sung by the women of the bridegroom's side when he prepares to start for the house of the bride for Niccah ceremony.

Dress up well our handsome Rasulbhai
 Dress up well, Your mother-in-law is anxious to see you
 Dress up well, that a prince cannot stand a competition
 With you he may fall back if at all dares to do so.
 Dress up well for your sister-in-law wishes to see you
 Make her think for a while that you are far superior
 Far superior to her own husband.
 Dress up well Rasulbhai for she, your beloved, wishes to see
 Wishes to see you. Dress up so well, that she may be
 May be besides herself as soon as she sees you.
 She may be your everlasting loving wife.

A song sung by the women of the bridegroom's side when a yellow paste is applied to the body of the bridegroom. This paste 'pithi' is applied to the body by the barber and the women folk sing this song while they stand by the side of the bridegroom.

Who has sent these bullocks laden with this yellow paste !
 Pithi, is sent by the grandfather of Abubhai.
 Pithi, is sent by the uncle of the bridegroom,
 Pithi, is sent by the maternal uncle of Abubhai,
 Bullocks full of the paste, laden with the paste.
 Apply it to your body delicate as any thing in the world
 Apply it so that your fine white colour may appear
 To the greatest advantage.
 Apply it your body and make it full of fragrance
 The fragrance which may fill the marriage booth.
 The father-in-law will ask who is this king
 Who is this merchant prince come from Africa with ships
 Ships laden with wealth ?
 We will say that it is no prince, it is no merchant prince
 But it is the eldest son of Abhrambhai.

A song sung by women of the bridegroom's side as well by the women of the bride's side when they apply sweet and fragrant oil to the respective bodies of the bride and bridegroom.

Sweet scented oil who has brought it and who has
 bought it ? Who is the person from whom it is bought ?
 Sweet oil is brought and bought by Jasajibhai.
 It is brought and bought from oil woman Pani.
 Thanks be to the oilwoman who out of her feelings
 Mixed Mogra and Hena to the oil preparation.
 Sweet is the oil : sweet is the nature of Jasajibhai,
 And sweetest is the grace and the charm of youth of
 Abdulbhai the bridegroom (if the women of the bride's
 Sweetest is the grace and party sing this song they add
 charm of Mulibhai. the name of the bride)

A song sung by the women of bride's party.

Our Mulibai is a ray of the Sun.
 How will the owl of Abdulbhai the bridegroom stand by her ?
 Our Mulibai is a flower, verily a rose,
 How will the wasp of Abdulbhai the bridegroom fly by her side ?
 Our Mulibai is heavenly damsel.
 How will a poor mortal of Abdulbhai dare to look at her ?
 Our Mulibhai is God sent grace
 How will pitiable fellow Abdulbhai the bridegroom know .
 Her and placing the grace honour with folded hands and bent head.

A song sung by the women of the bridegroom's side.

What to talk about the charm of 'Shera' ?
 The artist's work too shone to a greater advantage
 Worn by Bhanojibhai the bridegroom
 How do the strings hang about his moon like face !
 How is the light of the lamps reflected !
 Bhanojibhai has already dressed like a prince
 But the 'Shera' makes a king of him.
 The father-in-law and his wife will go mad after him
 And readily will offer their choice gift Rupbai to him.
 And the couple will be the most charming in the land.

A song sung by the women of the bride's party a Phatana. (A Phatana is a semi-humourous and semi-jocular sung in a little bit of loose and many meaninged abusive language).

Yes, thou father of the bride, thy wife always looks young,
 Why is it so dost thou know ?
 If the fact is not known to thee let me tell you.
 She leaves thee sleeping and befriends with our Abubhai.
 He feeds her and dresses her with the best dress, gives her gifts
 and ornaments and keeps her always pleased by offering
 her whatever she desires.
 Thou art a fool an incorrigible fool, how can this be known
 to thee, Thou art a beast having one notion
 The notion to drudge all day long through out the year
 We ask thee to note this and rejoice.
 Happy are the two husbanded woman is it not ?

A song sung by the women of the bride's party (A Phatana).

A black coloured donkey stands on the outskirt of our village
 He is making water.
 Rasulbhai the father of the bridegroom gazes at it.
 He thinks it is a cow making water.
 Ho, he runs and with his hands tries to gather as much urine
 as his two hands can hold and drinks it. He is thirsty
 Poor Rasulbhai quenches his thirst by drinking the urine of a donkey.
 The donkey begins to go Rasulbhai follows him and begs him
 to give him something to eat. The donkey, the kind one
 gives him a sound kick.
 Rasulbhai goes weeping to his home and complains to his wife
 that donkey kicked him to his wife.
 She keeps him quite and wipes his tears.



FIG. 1 A Jat Durwan



FIG. 2 A Jat Woman Squatting



FIG. 3 A Jat Police Patel



FIG. 4—A Jat Villager



FIG. 5—Two Jat Friends



FIG. 6—Jat Women

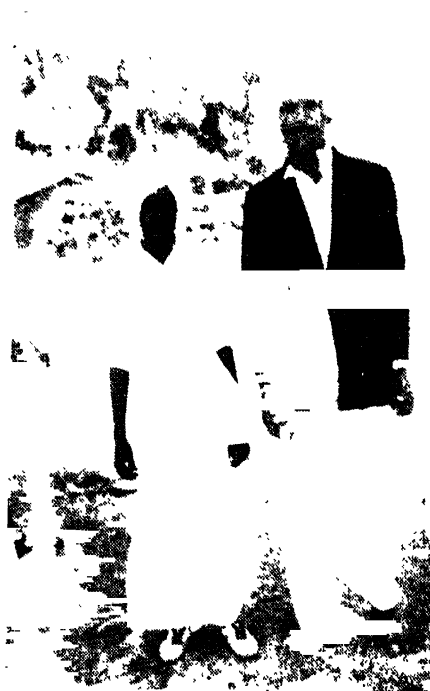


FIG. 7 Young Jats



FIG. 8 A Jat Agriculturist



FIG. 9 Two Young Modernised Jats



FIG. 10 Jat Labourers



FIG. 11 Jat Boys in Street



FIG. 12 A Jat Pasayta

વરનાળા આ પ્રથમ પ્રેમનું ગીત.

૧

આઠ કુવા નવ વાવડીરે,
ત્યાં કાંઈ રૂપાં પાણી જાય.
હાલોજી ત્યાંથી નીસરે રે,
રૂપ જોઈ એથી મોહી પડાય.
ધરે ગયા ધુમસુમ થયા રે,
માડી વાળી વાળી મોહા જોય.
ખાય પીએ ન બસે બાલતા રે,
એને નેણે નિંદ ન જરાય રે,
જેમ તેમ માએ વાતું જણીયું રે,
રૂપાં બાઈનાં માગાં કરાય રે.
દાદાજી એ તે માગાં મોકલ્યા.
પછે સગાયુના ગેળ ખવાય રે.

પોંખણાનું ગીત.

૨

ધીરે ધીરે પોંખજે વેવાણ.
ઘેર આવ્યો તારે રાયને રાણો. ધીરે.
સાંભેરે મા પોંખજે વેવાણ,
સાંભેલું તારે ખાંડવા જોસે. ધીરે.
ત્રાકે રે મા પોંખજે વેવાણ,
ત્રાક તો તારે કાંતવા જોસે. ધીરે.
રવાઈએ મા પોંખજે વેવાણ,
રવાઈ તો તારે વલોવવા જોસે ધીરે.
ધીરે ધીરે પોંખજે વેવાણ,
ઘેર આવ્યો તારે રાયને રાણો. ધીરે.

પરણ્યાના કોડનું ગીત.

૩

હાથી તે દાંતની માંચીએ બેઠાં,
ગોંધી બાઈ ગુણબાણ, કે બાઈ માંચીએ બેઠાં.
બેઠાં બેઠાં એને હૈયે હોયે રે,
પરણ્યા કેરા કોડેરે બાઈ, કે બાઈ.
આંખલે રૂડા મોર બેસે જેમ,
પુત્રે છે દલડાંના કોડ, કે બાઈ.
હાથાં દાદાજી કને ગીયાં રે,
દાદા શોધો મારી જોડ, કે બાઈ.
લાડકોલાલ હું સારખો રે,
આદર બકો અજોડ, કે બાઈ.
દાદાજી સુણી હસી પડ્યા રે,
હાહા સોષસું તારી જોડ, કે બાઈ.
પરણ્યા બત્તી બાતથી રે,
જોડી રેંધલ બાઈની જોડ, કે બાઈ.

ફટાણું

૪

ને ને રે બાઈ વર લાડકો રે,
 નેઈ હસજો તે મનડાં માંય,
 ને ને રે બાઈ વર લાડકો રે,
 કાણો એક આંખે, બીજીએ ભાજે નહી રે,
 મારે ફાંફાં તે ફાંકડા લાલ. ને ને રે૦
 કાને ખેરો એકે બીજો ન સાંભજે રે,
 ખેરા બરે છે ફાંકડા લાલ, ને ને રે૦
 એક નામેરું ફાટીયું બીજું દીસે નહી રે,
 નાકે નમડા ફાંકડા લાલ. ને ને રે૦
 એક હાથે હુંડા, બીજીને સાવ નહીં રે,
 એ રૂપના છે અવતાર. ને ને રે૦
 એક પગે લુગા બીજે લંગડા રે,
 હશે ધડાયા નવરો જેવી દીનાનાથ. ને ને રે૦

વરવાળાં પરણ્યા પછી આ ગીત ગાય છે ફટાણું.

૫

અમે અભરામ ભાઈને જીતી વળીઆરે
 જાણ્યો રાય ત્યાં નીકળ્યો રાંક
 જીતી વળીઆરે.
 બિચારો બે કર જોડતો.
 ભોજો દુખજો નમણું પડી. અમે જીતી.
 પાય પડી દીવ દીપરી રે
 અમે ઉતાર્યો રે ગમંડ. અમે જીતી.
 દાદાજીએ હોલો ક્યો રે
 પાસે બેસાડ્યે ઝાલી હાથ, અમે જીતી.
 દીપરી લીધ નીઆત ક્યો રે
 એને ધારણુ હૈયે દીધ, અમે જીતી.

કન્યાને મોકલવા માટે ઉતાવળ કરો એમ કહેતું ગીત.

ફટાણું

૬

મોકલો મોકલો રે વેવાણુ,
 વીરબાઈને ઝટ મોકલો રે;
 રથે જોડ્યા ઘેરી ધણધણે,
 સાભજો વાગે તે ધુધરમાળ;
 ઢોલ વાજે શણાઈ ફૂંકેરે,
 કંતાં સોંઢાડો ને હાલ;
 વેવાર કન્શો ન તો હાલશેરે,
 અમે મઠશું એની જાત.
 અમે છઠ્ઠાએ મોટા વેવારિયા,
 અમે રોકાણું ના પોસાય.

વરવાળાનું આવડાઈનું ગીત.

૭

અમે લાડડી જીતી લીધી રે,
અમે વાછડી વાળી લીધી રે.
એની માંડી દગતી દળણું રે,
એની બેનડી તોડતી તરણું રે,
અમે હસાવી રડાવી કાંધક.
લાડડી લીની રે,
એના માવડી છાણું ગમતી
એની બેનડી લદાણું વઢતી
અમે મીઠી કરીને વાત,
લાડડી લાંબી રે.
નળી માવડી આવી દોડી રે,
સાથ લાંબીતી બીજી છોડી રે,
રાખે આનેય પેલીની સાથ,
એમ લાડડી લીધી રે.

વરધોડો જોઈ કન્યા દાદાને પૂછ છે તેનું ગીત.

૮

જુઓ, જુઓ દાદાજી કોણ આવતું રે.
આવે રાજનો પાલણુહાર
કહો કોણ આવતું.
આ તે વાળ વાગે પિંધપિંધના
આવે રાજ કે કેઈ મહારાજ
કહો કોણ આવતું.
આને અંધારા કોણ ઉસેયતું
ભારી મશાલની શી રસ્નાઈ,
કહો કોણ આવતું.
મન કપ્યામાં કેઈ ના આવતું
દાદા કહે ઘરમાં ઘેલી જ.
કશે કેઈક આવતું.

પુત્રી અવતરે ત્યારે ગવાતું ગીત.

૯

ધણું જીવે અમારા લાલ
આંખડી તેજ તમે.
ધણું જીવે અમારા બાળ,
આંખુતા તેજ તમે
તમે અમારા ધરના દીવા છો
છો રાકતું સાયું રતન.

તમે આવ્યે થયાં અજવાળાં રે
 થયાં ઉજળાં લાકેતી મારે.
 તમે આવ્યે થયાં ઉજમાળાં રે
 જ્યમે કરશું તમારું જતન.
 તમે આવ્યે હરખ ન માયે રે
 નવ નીકળે મોઢે વચન.

પીઠીનું ગીત.

૧૦

પીઠીના રૂઠા પાડિયા
 સોંઠાડો નાજ. પીઠીનાં
 પીળી પીઠી કેળો માકલી રે
 એ તો માકલે દાદાજી રાજ. પીઠીનાં
 કેને કાળે તે એ મોકલ્યા રે,
 મોકલ્યા રસુનમાઈને કાજ. પીઠીનાં
 અરગળ કરતું મેકતી
 ગોળો ચોળાચો વરરાજ આજ પીઠીનાં
 બાંકેશે મંડપ શેરીમારે.
 ચોંડી ઉઠ્યે કન્યાની માય. પીઠીનાં

વરગળના શણગારનું ગીત.

૧૧

કોણ લાવ્યું આ તેલ કુલેલ
 મધમધતું સોડમે રે.
 કોણ ગાળ્યું આ તેલ કુલેલ
 મધમધતું સોડમે રે
 લાવ્યા જણામાઈ તેલ કુલેલ
 મધમધતું સોડમે રે
 લાવ્યા રસુનમાઈને કાજ
 મધમધતું સોડમે રે.

કન્યાવાળાંનું જમાઈને માટેનું ગીત.

૧૨

સૂરજ કિરણ મારે મુળીઆઈ
 વરરાજ અણુમાઈ ઘૂડ
 કે કેવી જોડ બની !
 ગુલાબનું ફૂલ મારે મુળીઆઈ
 વરરાજ અણુમાઈ જત.
 કે કેવી જોડ બની રે !
 ઉતરી સરગથી મુળીઆઈ પરી રે
 વરરાજ અણુમાઈ ભોટ.
 કે કેવી જોડ બની રે !

સુખડા મારે મુળીયાન રડી રે
 વરરાજા અયુમાન કાગ.
 કે કેવી જોડી બની રે !
 સૂરજ કિરણ મારે મુળીયાઈ
 વરગળા અયુમાઈ ઘૂડ.
 કે કેવી જોડ બના રે !

શેરાનું ગીત.

૧૩

શેરા કેવો બન્યો રે !
 કે કેવો શેરાનો ગુંથનાર
 શેરા કેવો બન્યો રે !
 શેરાનો ગુંથનાર ફાંકડો રે
 વધુ રંગીલો એ બાંધનાર
 શેરા કેવો બન્યો રે. !
 શેરા બાંધે અયુમાઈ ભાગડા રે
 દીસે પરચવી પાવનદાર
 કે શેરા કેવો બન્યો રે. !
 વાળી વાળી વરની મા નરખે રે,
 એને હૈથે હરખ ન માય
 કે શેરા કેવો બન્યો રે. !
 વાળી વાળી વરની ગેની નરખે રે.
 એને મોઠાં મલડી જાગ
 કે શેરા કેવો બન્યો રે. !
 ઘણું જીવા ઈસ્માલભાઈ ઘર પોમીર
 સખી થાંજા મારા વીર
 કે શેરા કેવો બન્યો રે. !

ફટાણુ

૧૪

હાંજ હાંજ રે રડી વેતણુ ફટડી રે
 હાંજ એતી નત નત નાની થાય.
 કે શેણુ ફટડી રે. !
 એ તો વેવાઈ ઈસ્માલને સૂતો વેચતી રે
 આપણા મોરણની બંચર થાય.
 એ એણુ ફટડી રે
 ભાઈ મોરણ વરાવે સુખડી રે.
 એતો ગંના પૂરે ભાઈ કેડ.
 શેણુ નહોય ફટડી રે.
 હાર એતો હથેલી માંહે થૂંકાવનાર,
 હારે વરગળા બીજા મ.વ.
 શેણુ નોય ફટડી રે.

ABSTRACTS OF THESES

Land System of the Madras Province

By V. V. SAYANNA

IT is generally recognised that the prosperity of agriculture is not only essential to the success and prosperity of all economic activities in other sectors of life as industry, trade and commerce but to an agricultural country like India, it is also in a large degree the economic basis of social progress and political stability. But in agriculture, land occupies a dominant position as compared with other factors of production and therefore the problem of agriculture is largely the problem of land. "The problem of tenures," observes H. Belshaw, "is of basic importance and is often a pre-requisite to other agrarian reforms."¹

To put in a nutshell, the subject matter of the thesis is the 'Land System' of the Madras Province' which implies in the main problems of tenures, tenancy, land transfers and conditions of agrarian labour in the ryotwari areas.

The work is divided into nine chapters and the chief lines of arguments are as follows: In the first chapter an attempt is made to analyse the physical basis of the province generally and to correlate the physical factors with the human factor. It opens the right perspective to follow the rest of the chapters. The second chapter contains classification of various land tenures of the province, *viz.*, the Zamindari, the Inam, the Ryotwari etc.; and the origin, development, distribution and degree of prevalence of each of these different tenurial types. A study of the land revenue system and of the motives underlying the evolution of the various land tenures is also made. The third chapter is devoted to a detailed study of the Zamindari system with reference to the financial aspect, rents, expenditure of incomes and general agricultural conditions as compared with conditions in similar neighbouring ryotwari areas. Chapter four is 'Land Transfers in the Ryotwari Areas' based on a comprehensive investigation, probably the first of its kind made in recent years. It examines causes of land transfers, and their economic significance, trends of land sales during 1930-45 in a few selected villages, the question of agrarian indebtedness, mortgage debt and their effects on land transfers. Tenancy problems form the subject matter of chapters five and six. Chapter five, broadly speaking, studies the aspects of farm tenancy which are more of a general nature *e.g.*, growth of tenancy, causes of renting, regions of high tenancy, tenancy types, level of rents, period of leases, conditions of leases, etc.; whereas chapter six examines in greater detail the sharing and fixed tenancy systems with special emphasis on the economic significance, factors favourable to their growth, income effects on lessors and lessees, and the general economic effects of produce sharing and fixed tenancy systems. Chapter seven on Agrarian Labour—in fact the question of agrarian labour is not different from the peasant and the land question—is divided into three sections. *viz.*, the first dealing with the agrarian classes, distribution and concentration of land; the second with the day and seasonal labour; and the last with the permanent farm servant. Chapter eight discusses tenancy legislation in Malabar and in the estates as well as the salient features of recent tenancy laws made in various provinces under the new constitution. The final chapter opens with an analysis of the general trends of recent land tenure policies in countries of Europe and U.S.A., discusses the different objectives of a land policy stressing the need to have an objective, lays down broad principles of reforms and makes some constructive scheme of proposals regarding abolition of the estates, tenancy situation, agricultural labour and generally on organization of agriculture.

It is apparent the work is not the last word on the subject. The land system, though primarily an economic problem, presents in its larger aspects many sides for discussion, appealing to the sociologist, the soil chemist, the technical experts and the statesman as well as to the economist and to all those workers carrying on work within and in allied fields of agriculture. It would be highly presumptuous, therefore, to claim to have covered the whole field and no scope is left for others, especially in a study like this based on the efforts of a student with limited resources in face of the vastness and complexity of the problem hitherto unexplored.

¹ Foundation of Rural Life by H. Belshaw *vide* International Labour Review March 1946.

Taxation of Incomes with Special Reference to India

By N. A. SARMA

IN this thesis a detailed discussion of the theory and principles of income taxation has been attempted particularly in Chapters 1, 2, and 3. It a tax system is to be sound, it must be progressive not merely in parts but in its over-all impact. Commodity taxation and other specific or general indirect taxes are regressive in incidence and are mostly levies on the poor. Chief reliance should be, it is maintained, on direct taxation of income because ultimately income is the best criterion ability to pay. Income taxation can supplement expenditure and other policies of the State in reducing economic inequalities in society. The effects of such a redistributive scheme of taxation on the incentives to work, save and invest are analysed. Throughout a comparative estimate of actual income taxation schemes operative in different countries, particularly of U.S.A. and U.K., has been attempted, as forming a necessary background mosaic. In regard to business income taxation, a separate chapter is devoted to the wartime expedient of excess profits taxation and the question is posed if E. P. T. can be adapted as a permanent feature of the fisc. American, British and the Indian E. P. T. Laws are studied together. Generally in treatises on taxation, the neglect of the theory of business income taxation is a lacuna which is sought to be set right in the section dealing with the corporation income tax. In the same chapter is also discussed the undistributed profits tax. Chapter VI is a study of Inter-governmental tax co-ordination and avoidance of international double taxation. While throughout a tentative estimate of the Indian Income tax system in the light of tax theory and practice abroad is attempted, Indian Income Tax Law has been studied in detail in Chapter VII. General Problems of income tax administration, the new administrative expedients that are being tried in recent times, with particular reference to the difficulties and needs of the Indian Administration, are examined, in the concluding chapter. Explanatory data and illustrative tables, pertaining to the fiscal facts and problems of India, U.S.A., U.K. and other countries, are included copiously. A select Bibliography is appended.

Customs and Manners of the Central Punjab

By USHA RANI KANAL

AFTER an introductory survey of the Punjab there has been given an account of the situation, climate, people and their occupation and their social classification of the Punjab. Two separate Chapters giving "a bird's-eye-view of the city of Lahore and general description of its life" are also given. The narrative begins with this chapter. It has been shown there how a Bengali family had driven towards Punjab from Calcutta during the war panic in 1912. There was one girl in the family, Nanu by name. She being interested in the customs and manners of the Punjab arranged meetings with her friends to whom she was introduced by a girl of her own caste. She first went round Lahore and saw all the historical places of the city. She came to know about the ways of greetings, dresses, shoes, ornaments that Punjab women wear from her Hindu, Sikh and Muslim friends. Leading a city life, the Punjabi girls did not know much about the village life. So, Amar, a Sikh friend of Nanu, took her to her village in summer vacation from where she got the required information about the life in a Punjab village. After staying there for few days, she went to Simla, a Punjab Hill Station, because her father had gone there. She felt happy because she thought she would be able to know about the Hill people also. She was lucky to get well-informed persons who could tell her about the hill people's life. She came back to Lahore after her useful trip into a Punjab village and into a Punjab Hill Station.

By this time she was introduced to the mothers of her friends. She requested her friends to arrange meetings for her with their mothers, so that she could get the first hand information about the customs observed among the various communities in the Punjab on the three important occasions- birth, marriage and death. She went to the ladies, put them questions and noted down all she wanted to know. So all the customs are described in question and answer form.

The rest of the chapters are written in descriptive form. Description of the religious life among Hindus, Muhammadans and Sikhs has also been given. Various superstitions current among the Punjabis are briefly described. Not to speak of the villagers but even the city people specially women are victims of superstitions. The women who

don't get children practice very ridiculous and sometimes even criminal devices for getting children. There is a true instance of a barren woman who killed the son of another woman. She did so, because somebody told her that if she would bathe in the blood of that male child, she would get a son. Sometimes women go to cremation ground and dance round the burning corpse, quite naked at the dead of the night, to get a son. Similarly there are various superstitions regarding lucky and unlucky births, marriage, lucky and unlucky days for business, etc., etc.

The emotional life of a people finds expression in its festivals and fairs. So a description of festivals of the people of the Punjab is given.

Some of the typical Punjābī proverbs are also translated into English. Proverbs represent the wisdom of the community in pithy and fitting language. A study of the proverbs is indispensable to the understanding of the life of a community. The following proverbs will show how the villagers express the wisdom and truth.

"Hathi varanj, sanēhi khētī,
Kadē nā hōndē bātiyam toṇ tēti."

The meaning of the proverb is that if business is left to others and cultivation of land is left to messages, then neither of them can progress from 32 to 33. The idea expressed is that business and agriculture always need personal care.

"Rajji mehn nam khandi khāl
Rajjyā jat uthāvē kal."

The meaning of the proverb is that a satisfied buffalo does not eat linseed powder and an economically satisfied Jat cannot but pick up a quarrel.

It shows a reading of the life of an average illiterate Jat. It is a fact that rural litigation increases when there is agriculture prosperity in villages.

So the proverbs are striking presentations of the racial experience.

An English translation of songs sung on different occasions has also been given. Besides this, the list of shalokas recited on different occasions among Hindu and Muslim prayers, list of terminology, list of usual form of courtesy titles and list of surnames are also given.

A general description of Hindu Community and other two powerful movements conclude the thesis. While making investigation it has been found that the heart of of the Punjab is as ancient as the land and it is jealously gardening its antiquity. Hindu women are found more conservative than men. While comparing customs of Hindu castes it has been found that the customs and ceremonies are almost same in all castes of the Hindus. But there is lot of difference of customs and ceremonies of the Punjab and other Provinces.

Muslims of the Punjab are more progressive than the Muslims of other Provinces. Mian Sir Fazal Hussain worked for the educational, economic and social regeneration of the Muslims.

There have been no revolutionary changes in the Muslim Community for it is free from many curses of the Hindus like caste-system, widowhood, etc.

There has been observed very little difference in the religious professions, social life and culture of the Hindus and Sikhs while going about the villages of the Punjab.

There are strong bonds of union between Hindus and Muslims in terms of their common languages, culture, art and music and social dealings.

The future happiness and prosperity of the Punjab depends mainly upon the spirit of harmony and co-operation between Hindus and Muslims and this task can be best accomplished by emphasising the essential unity of social and economic life. The Muslim League and the Hindu Sabha should not be allowed to excite masses, and if they do force access to villages, there should be powerful organization of Social Welfare Workers to meet them and to defeat them. It is through this that the vision of United Punjab—a strong arm of India—can be seen.

The Social Background of Hindu Muslim Relationship

By G. M. MEHKRI

A STUDY of the social background of Hindu-Muslim relationship was taken up in view of the importance of the subject to the prevailing political and social conditions in India.

The study commences with a brief outline of the early history of India. We see that before the Muslim contact with India, India had developed a high civilization of its own, with a record of many empires and with many great achievements in the fields of religion, philosophy and arts and crafts. We note in particular that India assimilated, absorbed and made its own many invading hordes from time to time. The Sakas and the Hunas are an example. We also note that even greater than this type of assimilation was the ideational assimilation. Hinduism not only re-absorbed Buddhism but also absorbed even primitive religions and gave them a place in the hierarchy of religious thought. Also it placed no restraint on thought. We note that at the time of the Muslim contact with India, there was no central government in India and after the breakup of the Empire of Harsha there were a vast number of mutually contending kingdoms and principalities.

We then see that Sind was conquered by the Muslim Arabs as a result of provocation. We note that although the Arabs ruled in Sind, the rest of India was little affected and that after a century of rule the Arabs practically gave up the last outpost of their empire. Incidentally we study the origin of Islam in Arab and note its vigorous monotheism and hatred of the worship of images. And we also note that in spite of this hatred, the Muslims allowed the Hindus in Sind to practice their religion freely if they paid a poll-tax. Then we see that it was with Mahmud of Ghazni in the 12th century A. D. that effective militant contact of the Muslims with the rest of India begins. We note that with this Muslim conqueror comes the great Muslim Scholar Alberuni who sympathetically studies the Hindu sciences and learning and notes that almost in every way the Hindus and the Muslims differ in habits and manners and customs. He notes that there was great hatred of the Hindus for the Muslims and for Mahmud of Ghazni. He also notes that Popular Hinduism is different from Hindu philosophy and thought.

Then we make a brief chronological study of the history of the Muslim rule in India from the invasion of Mahmud of Ghazni to the fall of Tipu Sultan.

Then we turn to a brief study of the early Muslim view of India and the Indians, and we note that while the early Muslim rulers regarded the Hindus as a lower people than themselves even the later conquerors like Timur, and Babar were sick of India so much so that Aurangzeb's daughter, Zeb-un-Nisa also wished that she were elsewhere than in India. This shows a tendency on the part of the Muslims not to mingle their fortune with the fortune of India.

Next we turn to a study of the Muslim leaders. We note that as a counter measure to Akbar's assimilative tendencies a line of Muslim Renovators arose, beginning with Ahmed Sirhindi whom the present-day Muslims joyously credit with the achievement of wiping out Din-Ilahi of Akbar. From Ahmed to Syed Ahmed of Bareilly there is an almost unbroken line of Muslim theologians who work against the Hindu-Muslim assimilative tendencies. After Syed Ahmed's death in 1828 for some thirty years Indian Muslims are without any leader and then after the failure of the Mutiny Sir Syed Ahmed Khan comes to the rescue of the Muslims. We see that he advises the Muslims to keep aloof from the newly founded Indian National Congress and he spiritedly protests against the desire of the Hindus to develop their language Hindi. Rt. Hon. Justice Amir Ali, another Muslim leader, frankly speaks and writes of the Hindu-Muslim differences and appeals to the British Government to protect the Muslim interests from Hindu encroachment as in government service. Then we see how Mr. Abbas Tyebji, while he advocates Hindu-Muslim co-operation in political affairs relating to the whole of the country, insists that in matters relating to the Muslims, Muslims alone should have the say. Then we study some views of Moulana Abul Kalam Azad who insists that the Muslims should not be cowed down by the fear of domination by the Hindus but should willingly co-operate with them with the consciousness of the essential strength of Islam. Then we study how Moulana Mohamed Ali, while eager for the freedom of India

was equally anxious that the Indian Muslims should not be dominated over by the Hindu majority. Thus we see that nearly all Muslim leaders in one way or another have striven to retain the individuality of the Indian Muslims.

Next we turn to a study of the question of language and literature, and see that in spite of the fact that Urdu developed as a language both of the Hindus and the Muslims, in places they came into close contact, with the passing of time it has assumed a distinctly Muslim colour not only because the Muslims are devoted to it more than to other provincial languages which millions of them continue to speak, but also because the Hindus have progressively taken to Hindi because of so many reasons like the commonness of elementary phonology of the Sanskrit all over India the existence of the best of mediæval religious literature of the Hindus in Hindi and the freedom to develop their own inclinations after the Muslims became powerless in India. We also note that the mind of the Indian Muslims has expressed itself best in the Urdu language. In a study of their poets of more than a century we see that their despair and their hopes are all clearly reflected in the Urdu literature. Thus we see that both because the Hindus are renouncing Urdu in preference to Hindi and because the Muslims are more and more endearing it to themselves, there is a linguistic separation also between the Indian Muslims and the Hindus, as there are distinctions between them in manners and customs, as studied in another chapter. Here it is seen that even those manners and customs which the descendants of the Muslims have adopted and the descendants of the Hindu converts to Islam have retained are of such a nature as to be mere superimpositions which can be and are being slowly discarded while the essential core of their manners and customs is the same as elsewhere in the world, in its being Islamic.

After this historical and sociological study of the Indian Muslims we turn to a study of the awakening in them of national consciousness as we know it in its modern sense, and we see that from Sir Syed Ahmed Khan to Mr. Jinnah there is a gradual and steady growth of the will to separate national existence of the Muslims in India, and the demand for the separation of the parts of India where the Muslims are in a majority from the rest of India is but the last rung of the ladder, which can be understood as the final demand of a people who have always been a distinct nationality.

BOOK REVIEWS

Depressed Classes. By Mohinder Singh, M.A., Ph.D. Hind Kitabs, Ltd., Bombay, 1947.

THE book deals with the economic and social survey of the Scheduled castes, called here the Depressed Classes, of Northern India—in the Punjab, U. P., Bihar and Bengal—who are estimated by the author to be 2.62 crores or who form about 62 per cent of their total strength in India.

Six out of ten chapters in the book are devoted to discuss the economic exploitation of these people under various influences,—small holdings, adverse physical environment where they happen to possess comparatively big holdings, excessive rents and illegal cesses charged by zamindars, *begar* extorted from these isolated and, therefore, helpless serfs, usurious rates of interests for credits made to tide over bad harvests, agricultural depression or uneconomic expenditure, inability to seek and receive justice in courts, etc.—and a large space in the concluding chapter is devoted to constructive suggestions by the author to ameliorate their condition and thus to help the process and programme of their uplift. The stress on the economic bondage of these people clearly indicates that, to the author's mind, the problem of the Depressed Classes is essentially economic and not social or political, and, therefore, can be best solved by special measures and legislation in that direction. It may be pointed out here that economic exploitation is not the special problem of the Depressed Classes alone but of many agricultural Hindu castes as well: and, therefore, cannot be looked upon as the root cause of the evil of untouchability. It may also be questioned whether economic uplift would really help to solve the problem of the Depressed Classes, more especially of the untouchables among them.

The social, civic and religious disabilities which the untouchables suffer from have been dealt with in a short span, but these disabilities and the measures on the part of the Government and other agencies to remove them need detailed exposition. Besides their abject economic dependence, inferiority complex on the part of the untouchables themselves inbred through treatment meted out to them for centuries and through vigilance taken by higher castes to see that they do not develop notions of self-respect, prejudice against them deep-rooted among the higher caste people are, among others, important factors cramping their life and annulling the efforts of both the reformers and the Government for their uplift. Again, the depressed classes have themselves imitated the Hindu pattern of caste, forming endogamous groups with commensal and contact restrictions and treating some groups as untouchables. Thus they are in the grip of caste in the abolition of which lies their salvation. The social side of the problem, as distinguished from the economic side, has been so cursorily touched in the book because, in the author's view, "the absence of any significant change in the social organization of the depressed classes can be accounted for by the absence of any fundamental change in the economic sphere."

Reference to the so-called criminal tribes is equally sketchy.

The author has done little theorising with regard to the racial identities of these people and to their conflict with the Indo-Aryans. The views expressed do not represent the opinion 'now generally accepted.' It does not form the main interest of the book and, therefore, may not be critically considered here.

A few diagrams, charts and tables given in the book add to the exposition of the subject. On the whole, it is a good study of the economic condition of the people concerned.

—K. M. K.

The Spirit of Industrial Relations. By H. S. Kirkaldy. Oxford University Press, London, 1947. Price Rs. 4.

PROFESSOR H. S. Kirkaldy, who is Montague Burton Professor of Industrial Relations in the University of Cambridge, was invited by the Tata Iron and Steel Co. Ltd., to deliver the Perin Memorial Lectures at Jamshedpur. The seven lectures he delivered in December 1946 have now been published in the book under review.

The term "industrial relations" is a vague term and may include under its scope any labour problem relating to Employer—Employee—State relations. Professor Kirkaldy's seven lectures, for example, cover not only problems of trade unionism, legal regulation of industrial conditions, incentives to work and joint consultation in industry but also such subjects as social security and the International Labour Organisation, which are but indirectly connected with industrial relations. Even in his first lecture, which deals with the spirit of industrial relations, we fail to find a definition of the term "industrial relations," though the origin of these relations is critically traced. "The problems of industrial relations arise with and from the divorce of the worker from the ownership of the instruments and materials of production," says Professor Kirkaldy. However, this is also the origin of all our modern labour problems, consequent upon the birth of what is known as the industrial proletariat.

Another limitation from which Professor Kirkaldy's book suffers is that though the lectures were delivered on the Indian soil, very few references to Indian industrial conditions could be made. Professor Kirkaldy admits that "human relations—and again in particular industrial relations—are inescapably bound up not only with the history of each people and the history of its civilization but also with the changing ideas of each people as to morality, political progress and the science of government." Great Britain and U.S.A. are the two countries which are closest in ancestry and thought and yet Professor Kirkaldy tells us that their methods in regard to industrial relations are entirely dissimilar. "What works and works reasonably well in Britain has failed in the United States; methods which have been tried and which have succeeded in the United States would undoubtedly fail in Britain." Professor Kirkaldy's conclusions are mainly based on his deep study of industrial relations of these two industrially advanced countries and hence one would naturally expect that they would hardly serve any useful purpose in case of Indian conditions. Professor Kirkaldy, however, believes "that there are certain fundamentals at the basis of industrial relations which are common to all countries and all stages of industrialisation, there are certain lessons to be learned from the mistakes and successes of other countries. What, however, it is important to avoid is slavish imitation of the methods and procedures of other people and other times."

And herein lies the value of the book. The principles expounded by Professor Kirkaldy have resulted from his intimate knowledge of the various aspects of industrial relations. History has tested most of them and found them fit for application in industrially younger countries. Professor Kirkaldy has a lot to say about the importance of machinery for negotiation and collective bargaining in industrial relations; about the origin, the objects and structure of trade unionism; about legal regulations regulating collective bargaining, recognition of trade unions, closed shop agreement, health, safety and welfare of workers, minimum age of entry, medical examination, hours of work, night work, occupations of women, determination of wages, conciliation and arbitration; about the desirability to utilise various forms of incentive in industry, such as the pains and penalties as also material reward in proportion to the energy and skill expended; about the origins, existing systems and the objects of social security; about the value and the various forms of joint negotiating machinery in industry for the settlement of wages and working conditions; and lastly about the International Labour Organisation, its constitution, its objects, its methods and its achievements. In each lecture, the usual method followed is to state the origin of the particular labour problem, trace its history (mainly in light of British conditions), review the existing position and lay down the conclusions reached. In India, it is for the trade unionist, the employer, the State authorities and the student of labour problems to study these conclusions and examine how far they can be made applicable to industrial conditions in India. An important, though inadequate, attempt in this direction has been made by Sir Harsidhbhai Divatia, till lately President of the Industrial Court, Bombay, in his Foreword to Professor Kirkaldy's lectures.

—S. D. P.

Assam. By Alban Ali and Erric Lambert. Oxford University Press. Pages 32. Price As. 6.

THIS is the 37th pamphlet in the series, entitled "Oxford Pamphlets on Indian Affairs," published by the Oxford University Press. The joint authors have had a long and varied experience in Assam. One of them Mr. Alban Ali served over 16 years with the Indian Police in Assam, and took part in the Hind world War as Flight Lieutenant, while the other Mr. Erric Lambert was with the Nagas throughout the Japanese invasion.

Before 1941 the people of India hardly realised the importance of their north-east frontier. With the Japanese occupation of Burma, Assam sprang into prominence. The province had to bear the brunt of the enemy attack, and as the authors proudly note, the people of Assam rose to the occasion and stemmed the tide of the enemy invasion.

The brochure is packed with information from cover to cover. On the inside second cover a map of Assam is given enabling the reader to follow quickly the account given. In the opening chapter the authors draw attention to the unique features of Assam. The province has the wettest spot on the earth (Cherrapunji,—average rainfall over 400 in. Highest record 905 in. in 1861), the biggest village in the world (Baniyachang, population of 42,000), and the largest freshwater island (Majuli in the Brahmaputra, 56 miles long and 10 miles broad). This is followed by a brief account of the country, climate, fauna and flora of the land.

Assam has a long history. The country is referred to in *Mahabharata* as the Kingdom of *Kamrupa* of the *Mlechha* King *Bhagadatta*. The authors believe that the present name of the province is derived from the Sanskrit word "Asama" meaning "peerless." After the *Mahabharata* nothing is heard of Assam till almost the beginning of 16th century with the exception of a reference made by the famous Chinese traveller "Yuwan Chwang." For a time a line of "Koch" kings ruled Assam, but the country was soon invaded by the "Ahoms." The Moghal Viceroy of Bengal also entered the field, making Assam a "Scene of three cornered fight." The Koch power perished. The present state of Cooch Behar outside the province is the only sign of its existence. The Ahoms permanently resisted the Moghuls, but because of internal quarrels, surrendered the country to the British in the second quarter of the 19th century.

The most important industry of Assam is Tea. As a matter of fact the rest of India knows Assam as a tea growing country. The authors bitterly complain that though Assam grows tea it does not make profit from tea. The provincial rebate on income tax paid on the profit made by the tea companies goes to Bengal as all the Managing Agencies are in Calcutta. Being a jungle province Assam has some income from timber, elephants, honey, beeswax, bamboo etc. Rice is the main crop of Assam, but the standard of cultivation being low, very little is produced beyond the actual need of the province. The province's resources are not yet sufficiently tapped. If properly exploited Assam has splendid hydro-electric possibilities. Economically the province has a great future. The authors rightly suggest that with proper developments this "Cinderella" province will have a proud position in the Indian Union.

—V. D. RAO

Revolution by Consent. By Dr. Dharendra Nath Sen, M.A., Ph.D., of the Calcutta University. Saraswati Library, C. 18-19, College Street Market, Calcutta. Pages VIII and 345. Price Rs. 10.

SINCE the release of Mahatma Gandhi and Working Committee Members in 1945 kaleidoscopic changes have taken place in the Indian political arena. The events have moved with such extraordinary rapidity that it is difficult if not impossible to fix one's gaze on any particular event. Indeed the sheer nearness of the object makes it almost impossible to have a clear perspective. Notwithstanding these difficulties an attempt is made by Dr. Dharendra Nath Sen to deal critically with the history of this stormy period.

After going through the book we find that it is planned and completed before the Mountbatten Plan was announced. While dealing with the history of recent events in India from 1940-46, Dr. Sen discusses certain basic assumptions. In a very useful chapter on the Constituent Assembly, he gives an account of the framing of constitutions of America, France and Russia and of the British Dominions like Canada, Australia,

South Africa and Southern Ireland. That Dr. Sen must be a very capable teacher is well seen from the lucid manner in which he has explained the intricate problem of proportional representation.

The British Cabinet Mission's Plan (1946) and the interpretation put upon it by the various parties in India have been an enigma to quite a few persons in India. Official Interpretation of the fateful paragraph 8 of June 16 statement brought a severe denunciation from Mr. Jinnah. "According to the ordinary and grammatical meaning of words and the accepted rules of construction" the author is "inclined" to accept Mr. Jinnah's interpretation. To him the sudden withdrawal of the June 16 offer seems "inexplicable." He "thinks" that, the Cabinet Mission and the Viceroy "felt that Mr. Jinnah alone could not deliver the goods, also further that the setting up of an Interim Government with the Congress in hostile opposition would defeat the purpose of Mission." After admitting all this, he accuses the Viceroy of "sheer political opportunism" with reference to the July 22nd offer. I beg to differ from the learned doctor. I should look upon it as political realism rather than political opportunism.

In his preface to the book, the author makes clear that he does not use the term "Revolution" in the "much too abused and hackneyed sense." While referring to the "Complex and vexed communal problem" he thinks that the "Muslim re-action in the shape of an organised agitation for Pakistan" is the result of what he calls "Hindu revivalism." A thorough survey of the Indian political firmament during the past ten years will convince one that the so called Hindu revivalism came after and not before the demand for Pakistan.

The book has been made more useful by adding a long list of forty four appendices. A few extracts from the Nehru report (1928) would have made the list more complete. Again the appendices should have been arranged in a strict chronological order. For instance the C. R. formula and the Pakistan resolution (Nos. 42 & 44) should have come much higher in the list. Care should have been taken while giving the dates on different documents. On page 287 and again on page 291 the dates given are wrong. Lord Wavell's broadcast appeal to League was on August 24 and not on September 24, again Pandit Nehru's first broadcast as Vice-President of the Interim Government was on September 7 and not July 7. In spite of these and other minor inaccuracies we must be thankful to the author for giving in one place a number of useful documents very necessary to reconstruct the recent history of India.

—V. D. RAO

Juvenile Delinquency and Destitution in Poona. By Mrs. G. N. Ruthonsha, M.A. Deccan College, Dissertation Series 4.

THIS thesis of 174 pages is a study of "The Bombay Children Act 1924, as applied to Poona with reference mainly to the cases" appearing "before the Juvenile court."

The main value of the book lies in the first hand study of 777 such cases covering the first five years of the application of the Act, 1935 to 1940. The authoress has taken considerable pains in gathering her data, and has sought to cover all possible details with a view to arriving at the causes of Juvenile delinquency and destitution and to determine the efficacy and the merits and demerits of the act as well as the machinery which operates it.

With this aim in view she devotes four out of seven chapters to a detail examination of these cases, narrates a number of cases at some length, and analyses the data in terms of the nature of offences committed, motives for committing certain offences, age and sex of the offenders, their health, religion and caste to which they belong, region and locality of their habitation, condition of their homes, seasons in which minimum and maximum number of crimes occur, etc., commitments meted out to them and execution of court orders in institutions and otherwise; their post disposal history. In the last mentioned however her efforts at gathering data have not been met with success, which will be no surprise to those associated with children's work in India. Consequently she is unable to arrive at any definite conclusion as to the benefits derived from court commitments and all that the child undergoes as a result of the order.

The remaining three chapters deal with a brief historical review of measures taken with regard to delinquency and destitution in India and abroad, and a detail survey of the machinery which works the Bombay Children's Act. In the concluding chapter

she offers a number of suggestions emphasising a sociological approach to the problem, concerned as she is with prevention and not merely treatment. In keeping with her findings *viz.*, that there were more cases of "destitution, neglect and victimisation," 66.2% than delinquency, she advocates legislation for social security and compulsory education of such a nature as would be in keeping with the needs and conditions of the society to which the child belongs. She maintains, "The Act can only hope to patch up things on the surface when the root causes lie untreated and that in part explains why the Juvenile Court does not meet with greater success." Her other recommendations are concerned with certain sections of the Act and the Machinery which executes the act especially the Juvenile branch which she thinks ought to be a separate department with a wider scope than at present, such as maintaining play centres, a research bureau, etc. Moreover she advocates the introduction of an All-India Children's Act which is indeed a long-felt need.

The book will prove valuable to those connected with children's work. Studies of this nature are needed in Provinces where the Children's Act is already in operation so as to furnish material for a proper estimate of the Act as well as to evaluate the extent to which social legislation can be an effective means of social control and social change in India.

—PERIN H. CABINETMAKER

Unemployment, Full Employment and India. By Nabagopal Das, Ph.D. (Econ.) Lond., I.C.S. Hind Kitabs, Ltd., Bombay. 83 pages. Price Rs. 2-8-0.

THE book is said to be an objective study of unemployment and full employment with special reference to India. The need for the book arose from the fact that much confusion prevailed (this is the second edition) in this country on this subject; the author therefore aims at a clear exposition of a theory of employment.

The first few pages deal with the first principles of full employment. The author follows Beveridge completely ("Full employment in a free society"). The exposition however is neither clear nor elegant. We are told that chronic unemployment exists due to a deficiency of demand; but there is nothing to tell us why it is so. There is a mention of the deflationary effects of saving (Page 12) which however is not shown as the determining factor. The reader is left guessing as to why there is not enough investment to offset the saving of the community. On page 43 the propensities to save and to consume are introduced suddenly. Dr. Das plumps straightaway for a manpower budget without any discussion of alternative methods of reaching full employment. The only reason he offers is the experience of war years. Similarly there is no discussion about the repercussions of adopting Beveridge's methods. Apparently he believes there are none. On the whole these pages contain more of assertion and obiter dicta than of argument.

The rest of the book is devoted to his principal thesis that a full employment policy is feasible in India. The State should undertake a manpower budget, *i.e.* undertake public outlay for a works policy as well as for subsidising private industrial expansion. It should be supplemented with measures for social security, an employment exchange service to ensure proper distribution of employment and a control of industry.

A full employment policy as conceived in industrially advanced countries is concerned with avoiding the deflationary effects of saving. The idea is to generate with the intervention of the State, demand for such a size of output as would require the utilisation of all available labour supply with the existing stock of capital and other factors of production, the technique of production being given. An adequate stock of co-operant factors is implicitly assumed in a policy of full employment. In India, however, unemployment is due not to a deficiency of demand but to a maladjustment of the factors of production. Population is increasing rapidly while land is fixed in supply and capital equipment is increasing very slowly. With a given production technique, if any factor is in overwhelming excess supply, unemployment or underemployment is bound to result. That is exactly so in India. Dr. Das reaches the same conclusion (Page 53) though his argument in one place is as follows. "The people are unemployed and underemployed because productivity is low (?). Productivity is low because labour is maldistributed among the different sectors of the economy." This would give the impression that we have means of correcting it and it is only a problem of shifting of labour.

If the crux of the Indian unemployment problem is a shortage of capital equipment, how far can the method of Dr. Das (and Beveridge) solve it? Dr. Das has nowhere made a detailed examination of his suggestion; he has merely asserted that such a policy would absorb all our surplus population. The first question is as to the extent of outlay necessary to bring all men into employment. Even though definite figures of unemployment are not available, estimates are made by Tarlok Singh¹ and D. Ghosh². It is estimated that there are about fifteen million surplus workers in agriculture. If all of them are to be absorbed in the near future, the outlay required would be tremendous. Besides Dr. Das would have us mechanise agriculture and aid industrial expansion. Where would all the money come from?

It will come from two sources: Taxes and loans. It is doubtful if taxes alone can raise so much money. With such low incomes, a policy which would tax only those who would save would bring poor returns. The second alternative of obtaining loans will have to be adopted. The amount of savings which the government can borrow depends upon the volume of savings. With a low income and a high propensity to consume, the volume of saving for society as a whole cannot be large. Hence the State can borrow funds only in competition with private industry. There is no reason to assume that the marginal efficiency of capital will be low in India in the coming years. In such a case the State may have to actually bid with industry for funds with a consequent rise in interest and a fall in investment. So a policy of public outlay might be actually detrimental to employment. Besides it must be borne in mind that there will be large leakages in the employment multiplier as we have to import capital goods.

Dr. Das often refers to the fact that large expenditure was undertaken in India during the War and bases the feasibility of his recommendation on such a measure being repeated in peace. Two things have to be noted. Firstly, private investment was at a standstill during the War and savings had to flow into government loans. Such a possibility does not exist in peace. Secondly, government expenditure was by means of created money. It is difficult to believe that this possibility is seriously considered (though see 4th line from bottom, Page 71); that way lies chaos.

Dr. Das's thesis thus is untenable. The problem of capital shortage cannot be solved by budgetary methods designed for quite another purpose. What is required is a deliberate policy of increased saving (and not a policy of providing offsets for saving) and a rigorous control over the entire economy to secure development along required channels. War economics provides us an example in so far as the entire economy has to be geared to any single objective. In the near future, employment will have to be a secondary consideration though its ultimate importance cannot be denied by anyone.

Dr. Das has not lived up to his claim of bringing light to the problem. The lay reader, including the policy-maker, will find the book confusing. The student of economics will find the treatment of the subject scrappy and inadequate.

—R. M. HONAVAR

The Economy of Ceylon. By Sir Ivor Jennings. Oxford University Press, Madras, 1948.

INFORMATION about the resources and the economic and social conditions of most of the Asiatic countries is fragmentary and Ceylon is no exception to it. This lacuna has been a serious handicap in the way of organised planning for the development of these backward countries. The need for full data is supreme now when reconstruction of the Asiatic countries is being seriously considered. Ceylon has attained her independence and would be shortly embarking on an ambitious project of planned development. Sir Ivor Jennings's book at such a juncture should be welcome and stimulate thought on the subject. The author has attempted to lay threadbare the important problems of Ceylon's economy in a simple and lucid style under a few broad heads, which should be very useful to the reader for an easy grasp. The available statistical material has been intelligently marshalled. The long and varied experience and association of the author with the island has enabled him to lend a practical turn to the discussion.

In the preface the author claims to have made an impartial approach. Unfortunately, the colonial people who have observed for a long time their economies in

¹ Poverty and Social Change.

² Pressure of Population & Economic Efficiency in India.

working would hardly be expected to agree with the views of the writers about their countries who, in the majority of cases, belong to the ruling race. A Ceylonese, for example, would hardly agree with Sir Ivor's observations that the plantation economy has resulted in the improvement of his standard of living and that there was no drain of wealth from his country. Similarly, he would also not subscribe to the view that a large-scale industrialisation of Ceylon is not a practicable proposition and that a predominantly agricultural economy is preferable because although there may be under-employment there is no unemployment under it, which is a recurring phenomenon in an essentially industrial economy. These genuine differences apart, the book would have served its purpose if it succeeds in avoiding planning in haste.

—M. B. DESAI

Asia in the Modern World. By H. Venkatashubiah. Asian Relations Conference, Indian Council of World Affairs.

THIS book was published at the time of the Asian Relations Conference held in New Delhi with the definite purpose, as Dr. A. A. Appadorai, Secretary, Indian Council of World Affairs, states in his preface, of providing "a ready reference book stating the essential facts concerning Asian countries in relation to the general political and economic development of the rest of the world." "The plan of the book" adds Dr. Appadorai "is governed by this objective. It starts with a brief account of the place of Asia in history and in the contemporary world; outlines the systems of government in the Asian countries, and lastly states the main facts regarding population economic resources, agriculture and industry."

The book is divided into three parts: (1) Introductory, (2) Political and (3) Economic. In the first part, after giving a short survey of the progress of civilisation in Asia since almost 5000 B.C., an attempt is made to evaluate the position of Asia in the contemporary world. The second part gives a short description of the systems of government in Asian countries as on the eve of the Asian Relations Conference. In part three the author deals with Asia's economic resources and their development. This Part has been divided into four sub-heads: Population, Economic Resources, Agriculture and Industry. Under each of these sub-heads is given a good amount of useful information regarding the various Asian countries.

The author has carefully abstained, throughout the book, from making any suggestions for future policies in any sphere. His aim is much more modest: "only to provide the essential facts which are necessary alike for the appraisal of the present situation and the formation of judgement for the future." And no doubt that has been done well.

—D. R. S.

Colonial and Coloured Peoples: A Programme for their Freedom and Progress. By Professor N. G. Ranga, M.L.A. (Central). Hind Kitabs, Ltd., Bombay, 1946. Pp. 222. Price Rs. 4-12-0.

THIS book, as stated in the preface, is a plea, from one who has himself passed through struggles and sufferings in the cause of the Indian People's Freedom, for the independence of all the Coloured and Colonial Peoples. The author, at the outset, traces the history of the so called programme for the emancipation of the subject peoples of the world's empires since World War I. All the subjects peoples quite enthusiastically espoused the Allied cause in that war hoping that the world be able to win freedom under the principle of self-determination which was accepted by the Allied leaders. Even the smaller nations of the world felt more sanguine about their future, "since they had been promised a League of Nations for the maintenance of international order. "But none of these hopes was however fully realised, for no statesman among the European Allies ever sincerely tried to achieve these aspirations, to enforce these promises, or to realize the new international order."

The Second World War too has, according to the author, "failed to approach the colonial problems in a rational democratic and honest manner." "This failure," according to Professor Ranga, "is as much due to the unpreparedness of the Anglo-American public opinion to appreciate the dangers inherent in the continuation of imperialism and the system of colonial administration, as the absence of clear objective before the colonial peoples themselves." The author makes a demand for the immediate declaration for the independence of all the colonial people not only because imperialism has impoverished and prostrated these people but also because "their historic

mission tends to lead them to a more progressive, democratic and universal way of life than that of Soviet Russia." Imperialism has led to many wars in the past and if it continues will surely lead to many more in the future. But the imperialist powers do not realize these terrible and calamitous possibilities; and that is so because "after all they are the victims of their 'communal matrix.'" The colonial peoples must beware also of the new form of imperialism, "the Socialistic imperialism of Western proletarian leadership."

The coloured peoples according to Professor Ranga are essentially progressive and have nothing to learn from modern socialism. "Indeed, if they are guided well by their own national leaders, they can surpass the Soviet peoples in developing a more progressive and humane social economy in the near future." After reviewing the thought and achievements of the Western imperialists, radicals and socialists, the author comes to the conclusion that they are not prepared to realize the need for immediate recognition of the independence of the colonial nations. The colonial and coloured people themselves must therefore demand "the recognition of their national independence by all the other nations of the world and ask their respective imperial powers to quit their countries." To make this demand effective an international effort has to be made to help the colonial people to develop their own freedom front: "the champions of colonial peoples must hasten to kindle the torch of freedom in every country and to rouse the people in every nook and corner of the Colonial World." Hence the founding of the Colonial and coloured Peoples' Freedom Front by the author in 1942.

The author, having "no faith in the humanity or uplifting character of capitalism," believes that the efforts for the economic and social advancement of the colonial and coloured people must be in keeping with their "spontaneous and traditional march towards Socialism." For this the organization of a cadre of 'International Social Servants' is suggested. This cadre of the I.S.S. is to function under the direction of an International Government consisting of the representatives "of all the countries of the world at least as many countries as possible, including of course, the countries of the coloured peoples too." The costs of the I.S.S. are to be borne by the International Government. "The industrialized countries can certainly afford this contribution."

In addition to the costs of the I. S. S., these colonial countries will require vast capital resources for a rapid agricultural and industrial development. The author, of course, is not ready to "allow the various private companies or Banks of different creditor countries or even their governments to advance this capital, lest the evils generally associated with such investment should afflict these nascent countries also." To avoid such a possibility: "The International Government shall develop a special Bank and Industrial Corporation and Agricultural Development Board. It shall invite deposits and investments from various companies, individuals and Governments of different countries in the world at specially reduced rates of interest. Then all these various Boards shall re-invest all the resources thus obtained in different industrial and agricultural enterprises in the undeveloped countries according to the agreed national plan. If need be the Boards may levy quotas of investment, as between different creditor countries and expect them to offer the necessary investments, no matter whether the funds are contributed by their Governments, banks or individuals or all these in combination." It is of course too much to expect such vast financial resources to flow on charitable basis; they will have to be raised as business propositions. That being so what grounds are there to believe that these investments will be so very different in their economic and political character from their predecessors or from the alternative that the author has discarded? That they will be undertaken through the agency of the International Government—itsself an organization dominated by the creditor countries—is no guarantee that these investments will not bring in economic and political domination by the investors. As business propositions, the creditors are bound to demand some security for their loans. But then the question is what security can the International Government offer? Obviously it must be the security of the resources and production in the borrowing countries. Will not this search for security necessitate some sort of economic and political control over the debtor countries? Will not, in that case, the new organization, dominated by the erstwhile exploiters, develop—or degenerate—into a new form of exploitation? It is perhaps too much to expect exploitation to end suddenly on the formal acceptance of the political freedom of these backward countries. All the social reformers who believe in changing overnight the exploiters into the trustees of the welfare of the exploited are sure to be disappointed. The book under review thus, though successful in giving the diagnosis of the situation, has failed in suggesting effective remedial measures.

LIST OF THESES

Table showing M.A. and Ph.D. Graduates in History, Economics and Sociology from 1st January 1948, to 30th June 1948, with the title of their theses, etc.

Name of the Candidate	Subject of the Thesis	Name of the Professor under whom the Candidate worked	Name of the Institution
	M.A. <i>History</i>		
Motiwala, B. K.	Jamgasaji of Navanagar and the British	Rev. H. Heras, S. J.	St. X.
	Ph.D. <i>History</i>		
Khilnane, N. M.	Punjab Under the Lawrences (1846-1858)	Dr. A. Duarte	D. J. S.
	<i>Economics</i>		
Sarma, N. A.	Taxation of Incomes with Special Reference to India	Professor C. N. Vakil	U. E. S.
	<i>Sociology</i>		
Agharkar, A. J.	Social Background of Physical Education (With Special Reference to the Folk Dances of Maharashtra)	Professor G. S. Ghuryc	U. E. S.
Mehkri G. M.	Social Background of Hindu-Muslim Relationships	Professor G. S. Ghuryc	U. E. S.

BOOKS RECEIVED

- Annual Report of the Institute of Historical Research, University of London, 1946-47, Twenty-sixth.*
- Anthropometric Measurements of the Marathas*, by Mrs. Irawati Karve. Deccan College Monograph, Series No. 2.
- Changing Kinship Systems*, By A. Spoelke. Rep. from Anthropological Series, Field Museum of Natural History, Chicago, Vol. 33, No. 4, Jan. 1947.
- Cranial Capacities*,-- A Study in Methods, by W. D. Hambly. Rep. from Fieldiana-Anthropology, Chicago Natural History Museum, Vol. 36, No. 3, Feb. 1947.
- Industrial Court Reporter, The*---January-March 1948. Pub. by the Directorate of Labour Information, Government of Bombay.
- Khadwidyapraseshika*. Pub. by the Navajivan Karyalaya, Ahmedabad.
- Site Excavations at a Mogollon Village, Western New Mexico*,-- the Third Season, 1946, by Paul S. Martin and John B. Rinaldo. Anthropological Series, Field Museum of Natural History, Vol. 32, No. 3.
- Toggle Harpoon Heads from the Aleutian Islands*, by G. I. Quimby. Rep. from Fieldiana-Anthropology, Chicago Natural History Museum, Vol. 36, No. 2, Dec. 1946.

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Empire Cotton Growing Review
India Quarterly
Indian India
Insurance Herald
International Affairs

Journal of the Andhra History and Culture
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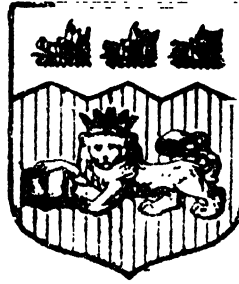
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PART 2

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HYMNS TO INDRA IN MAṆḌALA I

[4-11, 16, 29, 30, 32, 33, 51-57]

(Translated and Briefly Annotated)

BY H. D. VELANKAR

4

(1) DAYBY DAY, we call upon that maker of lovely forms for a favour, as we do on a good milch-cow for milking. (2) Come to our libations of Soma; drink of our Soma, oh drinker of Soma. The wild joy of the wealthy (Indra) is indeed a giver of cows. (3) May we then obtain your innermost favours. Do not neglect us; do come. (4) Go away; ask any learned man who is of the choice of your friends about the fierce and invincible Indra. (5) And let our revilers say to us:—You who do service to Indra alone have lost every other thing; (6) or, let the rich patron (and) the common people call us fortunate, oh wonder-worker. We shall surely be in Indra's protection. (7) To this active (Indra) bring this active (Soma), which resorts to the sacrifice, which gladdens the warrior and which quickly delights the friend (i.e., Indra). (8) Having drunk of this you became the deadly hammer of enemies, oh Śatakratu. You defended the powerful (warrior) in battles. (9) We strengthen you who are yourself a powerful (warrior) in battles,

4

(1) *a* and *b* are parallelly constructed, so that *goduḥ* is a dative of the noun of action *goduḥ* 'cow-milking.' Elsewhere, the word is used as a noun of agency; cf. I. 164.26 and VIII.52.4. At VIII.1.10 Indra is identified with a *sudugdhā dhenu*. On the other hand, a poet compares himself with an *adugdhā dhenu* waiting to be milked by Indra at VII.32.22. *surūpakṛtnum*: Indra's reputation for assuming different forms at will is well-known; see III.53.8; VI.47.18. Or, the word may mean 'giver of a beautiful form'; cf. VIII.4.9. (2) *revataḥ*: i.e., *indrasya*; cf. VI.44.11; VIII.2.13. (3) *ati vṛkhyā* 'to look beyond or away from' i.e., to neglect. Indra should neglect our enemies (VIII.65.9), but not us. *antamā sumatī* is a favour which is kept innermost in the heart and is not to be ordinarily distributed, being reserved for special favourites. The deity is often requested to take an offering or a hymn to his innermost heart; see on VII.22.4. (4) *prcch* with two accusatives. *yaḥ* very likely refers to *vipaścit* and not to Indra. *ā varam*: the same as *varam ā* with the dative of the person whose choice is meant; cf. VII.70.5; IX.45.2; X.25.11. The stanza is addressed to a doubting Yajamāna. (5) *a*: cf. I.74.3a. *b*: literally 'You have gone away even from an ordinary thing (*anya*).' *ārata* is Aorist 2nd plu. of *ar* to go. (6) *ariḥ*: 'A rich patron,' who has won Indra's favour through us, in contrast with *nidaḥ* in v.5. In vv.5-6 the poet explains the attitude of himself and his party:—Let the people call them fools or wise men, lucky or unlucky, they would never swerve from their loyalty to Indra. (7) *patayat* is an adverb meaning 'quickly' like *dravat* at 1.2.5 etc. *c*: *mandayatsakham* formed like *śravayatsakhā* (Indra) at VIII.46.12 and *dravayatsakham* (*aścm*) at X.39.10. (8) *b*: cf. VIII.96.18; also III.49.1 and VI.26.8. *vājeṣu vājinam*: cf. VII.32.14. Indra is himself called *vājeṣu vājin* in the next stanza like Agni at III.27.8. *vāja* is used in various senses in the Rv:—(1) food, sacrificial or otherwise; (2) strength; (3) battle which helps to win food; and only rarely (4) a horse (= *vājin*) as at V.84.2; X.106.5. It generally means a rich prize or a treasure to be won at races and battles. *vājin* is very commonly used of deities and men, horses and chariots alike. Its general sense is

oh Śatakratu, for the acquisition of riches, oh Indra. (10) Sing to that Indra, who is a great stream of wealth which is easy to cross, and a friend of the sacrificer.

5

(1) Do surely come ; sit down ; praise Indra in your songs, oh friends who bring him hymns: (2) Indra—who is the vastest among the vast, and a lord of covetable gifts, when the Soma is pressed. (3) May he be by our side in our active service for the sake of wealth and abundance. May he come to us with gifts of food. (4) Sing to that Indra whose horses the enemies cannot oppose in battles when they clash against him. (5) These pressed and pure Soma juices mixed with curds go forth to the drinker of Soma for his enjoyment. (6) You who grow mighty in an instant were born for the drinking of the pressed juice and for all-round superiority, oh wise Indra. (7) May the quickly effective Somas enter you, oh Indra, lover of hymns. May they be agreeable to you, a wise god. (8) The hymns and praises have strengthened you (in the past) oh Śatakratu. May our songs glorify you (today). (9) May Indra whose favours are exhaustless and in whom all manly powers dwell conquer this thousandfold treasure (for us). (10) May not our mortal (enemies) injure our bodies, oh Indra lover of hymns. Having complete control over them separate their weapon (from us).

6

(1) They yoke the ruddy Bradhna, who moves around the stationary world. His brilliant rays shine in the heaven. (2) They yoke to the chariot of this Indra his lovable, ruddy and bold horses who stand on

powerful, rich and so on. (10) Cf. VIII.32.13. *supāṇḥ* 'easy of access' used of Indra at VI.47.7 ; VIII.13.2. *rāyo arāṇḥ* : Cf. *caso arātem* at I.54.1 and note on it.

5

The hymn seems to have been composed on the occasion of an expedition for loot as is seen from words like *yoge* (v.3), *saṁsthe* (v.4), *tājam sanet* (v.9) and v.10. (*ā--ā ita* : The repetition of *ā* with *tu* in between is a stylistic peculiarity indicating emphasis ; cf. *ā tu ā gālī* IV.32.1 ; VIII.82.4. Or, perhaps construe *ā* with *nī śūata* (cf. I.28.8 ; IX.104.1) and take *ā ita* as parenthetical. *c--stomacāhas* : This word is only once used of the deity (VI.23.4) ; but otherwise it is used of a worshipper. *tāhas* means an offering and the compound is Bahuvrīhi. (2) V.2 is to be construed with v.1 ; both are addressed by the poet to his followers. (3) *b* : For a similar use of both the dative and the locative of purpose side by side, cf. I.10.6 ; in both the places the dative *rāṣe* seems to be used as the locative *rāvi* was out of vogue. *purāṇī* is fulness, abundance, etc. Cf. I.110.7 ; 180.6 ; IV.22.10 ; VII.32.20. (4) *saṁsthe* : (loc.) from *saṁ* and *stthā* ; it means 'coming together, clash,' etc. *Sāvāna* takes the word as an adj. of *hari*. But cf. VIII.21.11 ; 32.11 etc. (6) *b* : cf. III.31.13 ; VI.19.2 ; VIII.12.4. (8) Cf. I.11.1. (9) *c* : cf. VI.36.3. (10) *tanūmām* may also be construed with *iśārah*.

6

The hymn is a morning prayer. Vv.1-3 describe the daily glorious appearance and approach of the three luminaries, the sun, the dawns and the sacrificial fire towards the sacrificer, the rise of the sun being ascribed to the activities of the ancient poets, the Angīrasas, in v. 1. At such a time the poet yokes Indra's horses that he too may visit the sacrificer. The daily birth (as it were) of the three luminaries is praised in v.3, where the Angīrasas and Agni are addressed. This reminds the poet of the mythological event about the recovery of the luminaries, where Indra, the chief object of the hymnal praise and the ancient poets Angīrasas (already alluded to in vv.1 and 3, the vocative *marjāh* being an appeal to them to witness the beneficial results of their own activity) took a leading part (v.5). In v.6 the poet reverts to the present times and says how his hymns loudly praise Indra, while he is supposed to be led to the sacrifice by the divine Hotā, Agni, in v.7. In v.7 again the poet praises the lovely looking pair as they approach the sacrifice in the poet's mental picture about the situation. In v.8 the poet lovingly remembers how Indra is in the habit of singing in chorus with the poets. Finally, vv.9 and 10 end with the usual request for a reward. 'I do not agree either

either side (of the chariot) and who carry the warrior. (3) You, (oh Agni), are born along with the Dawns, bringing knowledge to the ignorant and bestowing form upon the formless, oh men ! (4) They adopt their (daily) birth once again according to their will, earning thereby a praiseworthy name for themselves. (5) You have won back the Dawns; oh Indra, with the help of the priests, who break open even the strong (forts), even (when they *i.e.*, the Dawns were imprisoned) in the cave (of Vala). (6) Like devoted men, our hymns have loudly shouted to the wise, great and famous Indra who wins riches for us. (7) May you look well indeed, when united with the fearless Indra. Both are delightful and of equal brilliance. (8) The glorious god sings mightily along with the faultless and pious bands of men who are beloved of Indra. (9) Come from this (earth), oh wanderer, or from the bright region of the heaven. The hymns strive to reach him together. (10) From here *i.e.*, from either the heaven or the earthly region or the vast mid-region, we request Indra about the prize.

7

(1) The Gāthins mightily praise Indra alone ; the singers praise Indra with their songs. The chorus-songs have extolled Indra. (2) Indra alone is fondly associated with his horses ; they are yoked by hymns.

with Oldenberg (who sees Brhaspati in vv. 7 and 8) or with Geldner (who thinks the sun is meant in v.7). The reference in v.5 is without doubt to the Angirases ; but I think they are also alluded to in vv.1 and 3 as I have said above. On the other hand, ordinary mortal poets, the followers of our author, are meant in vv. 2, 6 and 8. The two gods in v. 7 are Agni and Indra.

(1) The subject of *yuñjanti* is the ancient poets, the Angirases, who are present before the poet's mind in vv.1-5. The ruddy horse is the sun. In *c rocānā* which are the bright rays of the newly enkindled fire, (also of the rising sun and Dawn) are the subject of *rocante* ; cf. III.55.9 ; VI.1.7 ; X.4.2 ; 88.5. (2) The subject of *yuñjanti* is *kāmyāḥ gaṇāḥ* of v.8. (3) Agni and the Dawns bring light and thereby enable men to distinguish things from one another. They are therefore said to be restoring their beauty and characteristic forms to things. (4) The subject of *erire* is very likely Agni and Uśasah of v.3 ; v.4 is conceived as a subordinate clause with *ye* supplied. This is why its verb is accented. *garbhatvam erire* *i.e.*, *ātmanam* : 'sent themselves to the state of a *garbha* once again.' Uśas is *punaḥ punaḥ jāyamaṇā purāṇi* (I.92.10) and of Agni too it is said *garbhe san jāyase punaḥ* (VIII.43.9). *c* : cf. I.72.3 ; 87.5 ; VI.1.4 ; 48.21 etc. (5) *usriṣāḥ* are the cows as well as the Dawns. (6) *giraḥ* is the subject of *anūṣata* ; cf. I.7.1 ; III.51.1 ; VIII.95.1 ; X.43.1. *matim* is an adjective of Indra ; cf. VIII.18.7 (adj. of Aditi). *devayanto yathā* alone constitutes the simile : 'like ordinary pious men, pious men as we are, our hymns etc. ;' cf. *viśo yathā* at I.25.1. (7) This is addressed to Agni, who is present before the poet's mind in vv.1,3, and 4. The poet imagines that he sees Agni and Indra brought in by him to the sacrifice ; the situation is similar to VIII.17.15 (see note). (8) *anavadyaiḥ abhidyubhiḥ gaṇaiḥ* : They are the human bards of Indra, very much loved by him (*kāmya*). *gaṇa* used of a band of worshippers as at I.117.3 ; V.79.5 ; VI.56.5 ; X.112.9 etc. But cf. VI.40.1 in particular for the idea in our stanza (*uta śra gāya gaṇa ā niṣadya*). Also see note on IV.16.3. For *anavadya* and *abhidyū* as adjectives of poets see I.47.4 ; VI.19.5 ; VIII.4.20. *makha* is Indra ; cf. III.34.2 ; also III.31.7c. *indrasya kāmyaiḥ* : cf. III.31.17. In the sentence, *indrasya* is really redundant when *makhah* (Indra) is already there ; but it seems to have been used to stress the construction of *kāmyaiḥ* with Indra and with none else : 'beloved of Indra.' (9) *ataḥ* *i.e.*, from this earth ; *parijman* is significant. He is a great wanderer and so it is difficult to say where exactly he is. *c* : *saṃ rñjate* (3rd Plural) : rush forth together. *giraḥ* is the subject ; cf. VI.38.3. (10) *itaḥ* in *a* is anticipative and elaborated in *bc*.

7

(1) *gātha* and *gāyatra* seem to be connected with the Sāma-singing, *arka* and *utika* with the Rk-singing. Cf. I.11.1. *vāniḥ* are probably resounding chorus songs. (2) *b* : *ā* is probably to be taken with the locative *harjoḥ* ; *vacyojā* is parenthetical. For the stanza ; cf. VIII.33.4. *hiraṇyayāḥ* : Indra is gold-coloured ; cf. V.38.2. *samṁślāḥ* is used either with a locative or with the instrumental ; for the latter cf. VII.56.6 ; X.6.4.

Indra the wielder of the bolt is golden. (3) Indra sent up the sun in the heaven that he may be seen for a long time. He flung open the rocky stall for the sake of the cows. (4) Protect us in battles and in fights for thousandfold prizes with your fierce favours, oh fierce god. (5) We invite Indra in a great battle or in a small (one), —Indra, who wields the bolt and is a companion of ours against the enemies. (6) Such as you are oh Bull, open up this moving treasure for us, oh liberal donor, being resistless. (7) I do not hit against his good praise by means of those better and better hymns sung to him at every deed of valour. (8) Being a resistless ruler, Indra urges to activity the people, as a leader-bull does his herds. (9-10) From every place and from all the people we invite your Indra, who all alone rules over all the people, the treasures and the five tribes. May he be our exclusive friend.

8

(1) Bring us oh Indra, for our protection, a treasure which wifts (more riches), which conquers, which is ever victorious and most copious; (2) With whose help we may overthrow our enemies by means of a duel with fists and with horses, being protected by you. (3) Being protected by you, may we hold your Vajra (in our hands) by means of our iron club, oh Indra. May we completely overpower our rivals in a battle. (4) May we overpower our fighting enemies with the help of our brave archers (and) with you as our companion, oh Indra. (5) Indra is great ; and surely may greatness much beyond this belong to the Vajrin, as also a power which is like Heaven (itself) in vastness; (6) (for the sake of) those warriors who enjoy it in a battle for the acquisition of descendants and for those priests-poets who desire to send their hymns

So it is also possible to supply *rathena* after *vacoyujā* in *b*, and construe *sammiślah* with both the loc. and the instru. But *vacoyuj* is not otherwise used of a *ratha* in the Rv. (3) *gobhiḥ* is *hetvarthe tṛtīyā* ; cf. I.62.5. *b* : Cf. I.51.4 and note. (4) *sahasroṣṭradhaneṣu* (Bahuvrihi) : *pradhana* is a rich treasure (I.16.92). (5) *na.hādhanē —arbhe* : The contrast shows that the word *dhana* is used by the poet in the sense of a battle, which is a source of wealth. *vr̥treṣu* : i.e., when the Vṛtras are to be conquered : cf. VI.25.6c. (6) *caru* is a moving treasure containing valuable gifts. According to Sāyaṇa it is a rain-cloud. (7) *na vindhe* : Cf. VIII.9.6 ; 51.3. In both places, the root signifies some act which is unfavourable to the deity. It is perhaps allied with the root *vyadh*. The meaning of our stanza seems to be : A real praise of Indra remains unaffected, is not arrived at, even when ever-new hymns are offered to him. For, Indra is too great to be adequately praised by our hymns. (8) *vamsagaḥ vṛṣā* : cf. VI. 16.39; VII.19.1 ; X.28.2; 48.10 ; and 86.15 for the simile. (9) cf. IV.17.2 ; VI.18.2. (10) *c* : cf. I.13.19 ; IV.25.6 ; 7.

8

(1) The adjectives show that the treasure is one which consists of sons and brave followers ; but even ordinary wealth may be meant. For a characteristic description of an ideal treasure, cf. X.47. 1-5. (2) Mark the emphasis conveyed by the repetition of *ni. muṣṭihatya* : cf. *muṣṭihā* 'a wrestler' at V.58.4 ; VI.26.2 ; VIII.20.20 (3) *ghan* is instrumental of *ghan* as at I.36.16 ; 63.5 ; IX.97.16. The idea is :—by holding our *ghan* in our hand we should prove as powerful as if we held Indra's Vajra in our hand. Or perhaps we have *ghanāḥ* (against PP.) as at I.4.8. But in any case *vaym vajram ā dadimahi* is a bold idea. Cf. VIII.56.1c. (4) *a* : *śuraḥ astā* : cf. I.70.11 ; IV.36.6 ; VI.64.3, *b* : *tvayā yujā* : cf. VII.31.6 ; VIII.21.11 ; 63.11 ; 92.32 etc. (5) *prathinā* is instrumental sing. of *prathiman* ; cf. *mahinā* of *mahiman*. *c* : cf. VIII.56.1c. (6) This is to be construed with v.5 by supplying *tebhyah* at the end of v.6. The object of *āsata* is Indra's *mahitvam* and *śaraḥ*. *b* : *tokasya sanitau* : acquisition of descendants is possibly the securing of the continuation of one's own line through long and vigorous life. Geldner thinks that this refers to the capturing of female slaves ; but this is hardly

to him (at that time) : (7)—Indra, whose belly drinking Soma excessively, swells like the ocean and whose tongues (move continuously while drinking) like vast streams of rivers (falling into it). (8) Thus indeed is his kindness great, loud-roaring and rich in cows. To a sacrificer it is like a ripened branch (of a tree). (9) Thus indeed are your mighty favours helpful to a priest like me, as also to a sacrificer. (10) Thus indeed are a hymn and a prayer much liked by him and have to be sung for Indra in order that he may drink Soma.

9

(1) Come Indra ; rejoice in our gladdening drink at all sessions of the Soma sacrifice. You are a great defender by your power. (2) Offer this delightful and active Soma to the delightful Indra who performs all (deeds of valour), when the Soma is pressed. (3) Be delighted with the delightful hymns as also with these libations of Soma, oh lord of all mer (and) possessed of a lovely chin. (4) These hymns are sent up to you ; not accepting any one else, they have gone up to you as their mighty lord. (5) Send carefully towards us your wonderful and covetable gift, oh Indra ; may it be extensive and powerful. (6) There, oh Indra possessed of ample glory, urge us so as to be full of force and fame that we may get riches. (7) Bestow well upon us ample and vast fame which is allied with cows and food, which is exhaustless and which lasts for all life. (8) Bestow on us ample fame, glory which is the best winner of a thousand and those (well-known) foods which are carried in cart-loads. (9) (We stand) praising with our hymns that praiseworthy Indra, the rich lord of treasures who goes to a call for a favour. (10) The rich patron sings a mighty song to the mighty Indra who is very fond of every libation of the pressed juice.

borne out by facts disclosed by the R̥gvedic hymns. (7) The identification of Indra with the *kukṣi* is intended to give prominence to it. As the ocean swells but is never overfilled in spite of the constantly falling rivers into it, so is Indra never satiated or overdrunk though he continuously drinks. The juices of Soma passing over the tongue into the belly are aptly compared with streams of rivers falling into the sea. *kākud* : the palate or the tongue ; the plural is used in view of the Upamāna in the plural and of the identification of the *kākud* with the juices passing over it in streams. (8) *eva* i.e., in proportion to the greatness of his belly and amplitude of his drinking. He is not merely a great drinker ; but also an equally great benefactor. *virap̥śi* : boisterous, loudly announcing its existence to the people. Indra himself is called *virap̥śi* at III. 36.4 ; IV.17.20 etc., *pakvā sākhā* i.e., a branch of a tree laden with ripe fruit. See III. 45.4c ; IX.97.53d. (9) *vibhūtayah* is an adjective of *ūtayah* ; cf. *vibhūtiḥ sūnītā* I.30.5 ; *rayiḥ* VI.21.1

9

(1) *somaparvan* is the festive day on which Soma is offered to the deities. Cf. I.94.4 (*parvanāparvanā*). *abhiṣti* with accent on the last syllable is an adjective meaning 'one who helps.' (2) *enam* is *somam* and *sute* is locative absolute. Cf. I. 16.4 and VIII.45.22 *ab* in particular. Oldenberg and Geldner differ : they take *enam* as referring to Indra 'Send him down to the pressed juice ; send the delightful soma to Indra' etc. They supply *srjata* in *b*. (3) The locative *savaneṣu* is to be construed both with *matsva* (which governs instru. as well loc.) and *sacā*. (4) *ajosaḥ* : 'not accepting any one else.' Or perhaps, *ajosaḥ* means 'separately, individually, vying with each other' etc. as against *sajosaḥ*. According to Geldner it means 'unsatiated'. Oldenberg takes it as a noun meaning 'discontents' : 'Our discontents have gone up to you that they may be removed.' (6) *tatra* i.e., *rādhasi*. (7) *c* : *viśva-āyuh* adj. of *śravas* (neu.) or of Indra (mas.) : 'beloved of all men.' *āyus* or *āyu* preferably the latter—is the second member of the compound ; cf. *viśvāyu rādhas* I.57.1. (8) *rathinīḥ* : 'which must be carried in carts.' Cf. *rathyam rayim* VI. 49.15 ; *rathyo vājān* I.121.14 ; *rathīr iṣaḥ* III.36.11. (9) *gṛāntah* is used in place of a finite verb. *homan* (from *hū*) is a call ; an invocation ; cf. VIII.63.4cd. Also I.17.2 ; VI.23.4. (10) *ariḥ* is the rich patron ; cf. I.4.6.

10

(1) The Gāyatra-singers sing to you ; the reciters of Arkas recite the Arka. The priests have raised you up like a bamboo (for their support), oh Śatakratu. (2) When the sacrificer has mounted upon one peak after another and seen much that was yet to be done, Indra knows his destination ; the mighty bull sets himself in motion along with his herd. (3) Yoke surely the powerful steeds with lovely manes, who fill their girdles well. And then, oh Indra drinker of Soma, move nearer for hearing our hymns. (4) Come to our hymns ; sing, roar and thunder aloud. Glorify our hymns and also our sacrifice, oh god, Indra. (5) An Uktha which is glorifying to a liberal donor, must now be sung to Indra, so that the strengthener (*i.e.*, Indra) may rejoice in our Somas and friendships. (6) Him alone we approach for friendship, him for riches and him for physical strength. May that strengthener also strengthen us, giving us riches. (7) Open up the stall of cows, which is a glory given by you alone, which opens itself up quickly and yields (*lit.* drives out) its cows easily. Bring us your gift, oh wielder of the Vajra. (8) For, the two worlds cannot push you farther when you are infuriated. May you conquer for us waters which enjoy the sun's light. Shake off cows for us (like ripe fruit from a tree). (9) Hear my call, oh Indra whose ears are sharp ; put these hymns of mine in you without hesitation. Make this hymn of mine nearer to (your heart) than even a dear companion. (10) For, we know you to be the mightiest hearer of a call for help, in battles. We invoke the help of the mightiest god which most easily wins a thousand. (11) Do surely (come) oh favourer of the Kuśika priests. Drink the pressed juice, being filled with wild joy. Prolong our budding life very well and make the poet a winner of a thousand. (12) May these hymns surround you on all sides, oh lover of hymns. May they be our strengtheners through you, who help men to power. May they make us happy being gladly accepted by you.

11

(1) All hymns glorify Indra who is as spacious as the ocean, who is the best among the chariot-fighters, a good leader and a lord of foods. (2) Enjoying the friendship of you the mighty one, may we never fear

10

(1) *d* : *vaṁśa* is the main supporting pillar on which some structure or building is made to rest. Compare the word *avamśa* at II.15.2 ; IV.56.3 ; VII.58.1 etc. For *ab* see above on 7.1. (2) *a* describes the sacrificer's work in collecting the Soma stalks from mountains and *b* his other preparations for the sacrifice. *īṣṇi* is the leader-bull, here Indra ; his Yūthas are the Maruts. (3) *upaśrutim cara* is the same as *upa śṛṇu* at I.82.1 ; VIII.17.2 (4) *abhi svara* : cf. VIII. 13.27. *b* : See on IV.16.3. Also cf. I.6.8 ; 173.2 ; VIII.81.5. (5) *b* : See on I.5.3. (7) *suviṣṭam* and *sunirajam* are adjectives of *vrajam* which is identified with *yaśaḥ* ; cf. II.23.18a ; III.30.7b ; 31.10ab etc. Perhaps *b* is parenthetical. Oldenberg and Geldner construe *a* as a separate sentence with *tam* (*indram*) *invate* supplied from v.6 ; but this is not necessary. The *vraja* is of course of the enemy of the sacrificer ; cf. VI.45.24. (8) *na invataḥ* 'do not push you either up or down' *i.e.*, are completely filled up and are unable to contain you. *svarvatir apah* are waters that flow in the open sunshine and not in the dark caves : cf. VIII.40.10. *d* : cf. III.45.4c ; IX.97.53 *cd*. (9) *nu cit* is positive. *yujaś cid antaram* ; cf. VIII.18.19a. For *c*, cf. on I.4.3 and see VII.101.5b ; X.91.13c. (11) Supply *ihi* in *a* and cf. I.5.1, or construe *d* with *piba*. *navyam āyuh* : cf. III.53.16c ; VII.80.2a. (12) *pari bhavantu* : cf. VII.31.8 ; 104.6. *vrddhāyu* is Bahuvrihi. Supply *tvām*, *vrddhi* and *juṣṭi* are adjectives of *gi* introduced for the sake of a word-pun.

11

(1) *samudravyacasam* : cf. I.8.7 ; 30.3. Also cf. VI.34.3. (2) *mā bhema* : cf. VIII.4.7 ;

any one, oh lord of strength. We loudly praise you who are an unconquered conqueror. (3) Many are the gifts of Indra; his favours are never exhausted when he bestows upon his singers a gift of food accompanied by cows. (4) As the breaker of forts and a youthful poet, he was born with measureless strength. Indra the often-praised lord of the bolt, is the supporter of every sacred rite. (5) You opened up the cave of Vala who possessed the cows, oh wielder of the bolt. The gods, fearless though pressed hard, favoured you (by electing you as their leader). (6) I have returned with your gifts, oh Indra, loudly proclaiming the river. The singers have waited upon you, oh lover of hymns, (because) they knew that (deed) of yours. (7) You overthrew that wily Śuśna with your mysterious powers, oh Indra. Wise men know that of you. Amplify their glories. (8) The hymns have praised Indra who rules (over all) by his might and whose gifts are a thousand or, even far more than that.

16

(1) May the horses having the brightness of the sun bring you the mighty one for drinking Soma, oh Indra. (2) May the horses bring Indra in an easy-rolling chariot to these fried grains dipped in ghee. (3) We invite Indra in the morning, Indra when the sacrifice is in progress, Indra for the drinking of Soma. (4) Come to our pressed juice with your horses of lovely manes, oh Indra. For, we invite you when the juice is pressed. (5) Such as you are, come to this our hymn, to this libation of the pressed juice. Drink it like a thirsty bull. (6) These are the drops of Soma pressed and put on the sacred grass. Drink them for overpowering might, Oh Indra. (7) This foremost hymn should reach your heart and be most pleasing to you. And then drink the Soma that is pressed. (8) Indra visits every pressed libation of Soma for wild delight. The killer of Vṛtra (goes) for the draught of Soma. (9) Such as you are, fill our desire with cows and horses, oh Śatakratu. Being filled with pious thoughts may we praise you.

29

(1) Even though we are not well spoken of as it were, oh unfailing drinker of Soma, do make us famous for cows and thousands of lovely horses, oh Indra of ample gifts. (2) Oh lord of gifts, oh lord of powers

6.13. (5) *abibhyuṣaḥ*: Nom. plural (irreg.). *āviṣuḥ* 'favoured him i.e., by electing him as their leader; cf. IV.19.1 and note. (6) *sindhum āvaḍan*: The river near the home of the poet is meant. It figures in the hymn as a gift from Indra. Geldner is not right in assuming that the poet here announces the gifts received by him through Indra's favour to the river in the vicinity of his home, like another poet at VIII.74.15. The accusative *sindhum* precludes such a possibility especially with verb like *ā vad*. On the other hand rivers figure as objects of conquest in wars; cf. VI.25.4.

16

(2) *ghṛtasnu* is an adjective of *dhānā*; the Tatpuruṣa accent of the word shows that its second member is an adjective *snu* from the root *snā* to bathe: (bathing in ghee). At II.27.1 the same word with a Bahuvrihi accent is used as an adjective of *gīraḥ*; this indicates that the second member here is *snu*: which is but a short form of *sānu*, 'having ghee at its top.' (4) *sute-sutam*: cf. VIII.45.22ab and I.9.2 above. (5) *c*: cf. VII.69.6; VIII.4.3; 45.24. (7)b: cf. I.10.9 and note. (9) *ab*: Desire conceived as something like an empty bazar-packet to be filled with objects like cows etc.; cf. I.57.5; III.30.19; VI.45.21; VIII.24.6; 64.6.

29

(1) *an-āśasta* 'not praised, not mentioned with admiration etc.' from *ā-śas*. (2) *lova dāmsanā*: cf. VI.48.4b; *dāmsanā* (instrumental) is to be construed with the

having a lovely chin, with your wonderful power do make us famous for cows, etc. (3) Send to sleep the two devils whose appearance is illusive; may they sleep without waking. Do make us famous, etc. (4) Let the devils of miserliness sleep; let the deities of liberality awake. Do make us famous, etc. (5) Kill well the donkey-devil who brays in this wretched manner, oh Indra. Do make us famous, etc. (6) May the wind blow far away from the trees, along with the *Kundṛṇācī*. Do make us famous, etc. (7) Kill all the devils which shriek bitterly. Strike down the *Kṛkadāśū*. Do indeed make us famous for cows and thousands of beautiful horses, oh Indra of ample gifts.

30

(1) I bathe your Indra, the mightiest possessor of a hundred powers with streams of Soma, as those who long for loot do their horse. (2) Indra—who (drinks) a hundred libations of pure Soma and a thousand libations of Soma well mixed with curds. (The Soma) runs to him as (waters) run to a low level. (3) Because, when the Somas (gather) together in his belly for mighty wild joy, he *i.e.*, Indra makes room for them all, like the ocean. (4) This Soma is yours; you go to it as the male pigeon goes to its mate. You enjoy even that hymn of ours. (5) May your kindness be all-pervading—you to whom this hymn belongs, oh lord of gifts borne on hymns. (6) Stand up for our protection, oh *Śatakratu*, in this battle. Let us converse together in the midst of other men. (7) We as his friends invite Indra, who grows stronger in every undertaking, for the sake of protection in every battle. (8) May he attend to our call when he hears it, with thousandfold favours and foods. (9) From the home of the ancient one (Indra), I invite the warrior who opposes many enemies and whom the ancient one, my father invited for your sake. (10) We request you who are such, oh often

refrain. Or, *daṁsanā* is nom. sing. as at III.9.7 (yours is the wonderful power). (3) *mithūdṛśā*: The adjective is used of *Uśāsānaktā* at II. 31.5, where it is really applicable to the night and merely transferred to the Dawn. Or, does the word mean 'appearing in couples'? cf. VII.104.23. (5) *pāpayā amuyā*: cf. X.85.30; 135.2. *gardabha* is probably a Yātu in the form of a donkey; for such Yātus cf. VII. 104.22. (6) *kundṛṇācī* is some kind of a bird-devil which conveys an evil message from the top of a house or a tree. Cf. VII.104.18 where the Maruts are requested to destroy the devils who assume the forms of birds and fly during the night.

30

(1) *krivi* 'a race horse.' A horse must have his favourite bath before he can be made to work very hard; cf. VIII.87.1b; also II. 13.53; *vājayantaḥ* belongs to the simile and is an *Upamāna* for *aham* supplied. (2) The accent of *riyate* in *c* shows that its subject is not *yā* in *a*. So supply *pibati* in *a* and *somaḥ* in *c*. For the latter, cf. I.57.2; IV.47.2; V.51.7 etc. (3) Supply *indato yanti* in *a* and construe v.3 as a subordinate clause (with *hi*) as shown by the accent of *dadhe*. *c*: Cf. I.5.5; 11.1; III.36.8; IX.80.1. (4) *c*: *ohase* (connected with *śūh*) to consider, reflect upon, appreciate, etc. (5) For Indra's *sūntā* cf. I.8.8.; 51.2; III.31.21; VIII.13.8; 14.3; 45.12. (6) *c*: *anyesu* *i.e.*, *manuṣyesu* or, *vājesu* ('about other battles'). For *c*, cf. I.25.17. (8)a: Cf. VIII.1.15; also VI.45.23; 50.6. (9) Construe *anu* with *huvē*; *pratna* is Indra himself. *anuhuvē* 'I invite in imitation of my father who invited him for your sake.' The stanza is addressed to the *Yajamāna*, in whose service even the poet's father had invited the god. *okasaḥ* is ablative. *Sāyaṇa* takes both the words as forms of the genitive and supplies *sakāśāt*. Cf. VIII. 69.18a, where too *anu* is to be construed with the verb. But there *okasaḥ* is to be construed as a genitive of object. Geldner (and Oldenberg) construe *anu* with the genitives and translate: 'according to the old practice.' This is doubtful. *tuviprati*: *prati* is often used in the sense of *pratimāna* 'a rival,' either independently (I.55.1b; II.1.8d; VI.30.1; VIII.64.2; X.110.7), or as a latter member of a compound (*apratī* I.53.6. etc.)

invited lord of covetable gifts, oh divine friend to your singers; (11) Oh bolt-bearing Soma-drinking friend of us, who are your friends, who drink Soma and who possess lovely jaws (like you). (12) Let that be so, oh drinker of Soma, do so, oh friend Vajrin, as we desire of you, for our encouragement. (13) May rich (rewards) with ample foods belong to us when Indra becomes our companion at the sacrificial feast, by means of which we may rejoice, being rich in food stores. (14) Being yourself a relative like yourself to your singers, oh bold one, and (further) being requested to do so, you have, as it were, put the axle in the two wheels. (15) When you have completely (fulfilled) all desire and service of your worshippers (with rewards), you have put the axle as it were with your powers, oh Śatakratu. (16) Indra always conquers treasures by means of his neighing, roaring and powerfully breathing (horses). He the powerful one who is our patron, has given us a chariot of gold for the sake of conquest.

32

(1) I shall now proclaim the deeds of valour of Indra, which the foremost ones, the wielder of the bolt performed. He slew the Ahi, dug down the waters (and) ripped open the veins of the mountains. (2) He slew the Ahi resting in the mountain. Tvaṣṭā fashioned out the bright thunderbolt for him. Like lowing cows, the waters went down straight to the ocean, lustily flowing forward. (3) Behaving like a bull, he chose the Soma. At the Trikadrakas he drank of the pressed out juice. The bounteous one seized the projectile Vajra (and) slew this first-born among the Ahis. (4) You surely did not meet with an opponent, oh Indra, at that time when you killed the first-born of the Ahis and completely destroyed the wiles of the wily demons, producing in an instant, the Sun, the heaven and the Dawns. (5) Indra killed Vṛtra, more deadly (than others) even when he had lost his shoulders, by his Vajra which is a mighty weapon. Like trunks of trees felled down with

(11) *śiprīnām* : The feminine gender is striking as at V.53.10 ; 58.1 (*vaṇyāśīnām*). Or perhaps the word (masc.) is *śiprīni*. The worshippers are called *Śiprīṇis* to maintain the correspondence suggested by the *Sakhkya*. (12) *īṣṭi* is encouragement, instigation etc. For c cf. V.74.3c. (13) Supply *īṣṭi* or *burandhayaḥ* after *revātiḥ* in *a* : cf. I.158.2c. (14) The same simile is expressed in vv. 14-15 in two parts. *duca* and *kāma* are likened to the wheels of a chariot in which the axle is to be put (the objects of desire, understood, being conceived as an *Upameya* for the axle). (16) Supply *astaiḥ* in *ab*. *hiranyaratha* (Tatpuruṣa) : Cf. *hiranyapindān* as a gift at VI.47.23 c. *d* : *addt* (or *dāt*?) is perhaps past tense used to convey the sense of the Subjunctive. The *Anuprāsa* is characteristic.

32

The hymn describes Indra's duel with Vṛtra introducing many interesting details. (1) *vakṣaṇāḥ* either from *vakṣ* or *vaḥ* ; they are the water-carrying veins of the Parvatas by which non-showering rainclouds seem to be meant. But the poet has apparently identified these with the ordinary mountains (cf. v.2) and imagined that Vṛtra extends himself across these veins and prevents the waters from flowing towards their goal, the ocean ; cf. v.2, 8, 10, 11. (2) *b* : cf. I.61.6. *śaryo* is either from *śar* 'light' or from the root *śar* to sound : 'bright or buzzing.' c. cf. IX.13.7 ; X.75.4. (3) *Trikadrakas* are particular sacrifices called *Jyotis*, *Gau* and *Āya*. *kadrū* or *kadrūka* is a big wooden tub where the Soma juice is collected. Indra drinks from a *kadrū* (VIII.45.26). Indra is said to have drunk three such tanks of Soma before he went out to kill Vṛtra. *sāyakam* is adjective of *vajram* ; cf. I.84.11 ; X.83.1 ; 84.6 (4) *c* : cf. VI.30.5d. *d* : cf. X.54.2. (5) *vṛkṣam* is an adjective of *Vṛtra* ; cf. III.34.3 ; IV.18.9. He was so called because he was dismembered by Indra before he was actually killed. *vivṛkṣā* is the past passive

a hatchet Ahi lies at full length embracing the earth. (6) For, like an unopposed fighter, that insolent Ahi challenged the great warrior, the impetuous one who overpowers many. He did not bear the clash of the weapons of this (Indra); having Indra for his slayer, he crashed completely, breaking his nose by the crash. (7) Though deprived of his hands and feet, he still fought with Indra. Indra hurled his Vajra at his shoulders. The impotent (Vṛtra) seeking to be the rival of the mighty (Indra), lay down scattered in many places. (8) Gaining back their spirit, the waters pass over the Ahi who was thus lying helplessly like a broken thunderer. That same Ahi now lay under the feet of those very waters whom the encompasser had blocked up by his greatness. (9) Vṛtra's mother had her strength ebbing; Indra brought down his weapon upon her. The mother was above, the son below. Dānu lay down like a cow with her calf. (10) The waters variously pass over the invisible body of Vṛtra now placed in the midst of their never-resting, never-encamping streams. He whom Indra has killed has entered everlasting darkness. (11) Mastered by the Dāsa and guarded by the Ahi, the waters stood blocked up like cows by a robber. Having killed Vṛtra, Indra flung open that cave of waters which was closed. (12) Being a matchless god, you became a horse's hair, oh Indra, when he, *i.e.*, Vṛtra dealt you a blow on your jaws. You conquered the cows, you won the Soma. You sent down the seven streams to flow, oh brave god. (13) Neither lighting nor thunder proved useful to him, nor did even the mist and hailstorm which Ahi showered (on Indra). When Indra and Ahi fought with each other, the bounteous god conquered his foe even for the days to come. (14) What avenger of Ahi did you see oh Indra, that fear has seized your heart after killing him (and) that you have crossed the 99 rivers and the heavenly regions like the frightened

parti. of *Vraśc.* For the simile cf. II.14.2b. *skandhas* (neu.) is the trunk of a tree. (6) *ayodhā* is either a Tatpuruṣa or a Bahuvrīhi: it means 'a bad fighter' or 'one who had no opponent.' *rjīṣam* from *rj* to dash straight on. *rujānāḥ saṁpiṣe*: The former word is taken to mean rivets by Sāyana, who understands *saṁ piṣe* as an active form. But this does not seem to be right. The Atmanepadi form is passive and *rujānāḥ* is the subject of it. So it is to be split up either as *ruja amās*, or as *ruja-nās*, or as *rujā-an-ās*. It is an adjective of Vṛtra. *indraśatruḥ* Bahuvrīhi. Indra himself is *ajātasaṁtu*; cf. V.34.1; VIII.93.15. (7) *a*: cf. III.30.8. c:cf. I.33.6c. *vṛṣen* and *vadhri* are potent and impotent bulls respectively. *vadhri* is also used as an adjective in the sense of impotent or futile, in words like *vadhri-aśva*, *vadhri-vāc*. (8) *nado* is a roarer, thunderer, a challenging bull. *bhinna* is broken to pieces, shattered. Pischel and Geldner take *noda* to be the same as *naḍa* 'a reed.' But *bhinna* is not merely 'broken' but 'shattered to pieces'; *amuyā śayānam* has a clear reference to *purutrā aśayat yastah* (v.7d). *mano ruhānāḥ*: *manas* is often conceived as a chariot when the root *ruj* is used with it. *ruhānāḥ* (Atmane.) is used only here. The mind is often compared with a chariot in point of speed. So *macro ruhānāḥ* means 'mounting upon their own minds,' *i.e.*, gaining back their courage, spirit etc. *patsu* (Loc. plu.) *taś-śi* 'lying underneath the feet.' (9) *nīcā* (adv.) *cyāḥ yas cyāḥ sā*; Dānu is the name of Vṛtra's mother; cf. III.30.8. Everywhere else however Dānu is only another name of Vṛtra. (10) *abc* form one sentence; *nīyam* is an adjective of *śarīram* cf. *nītyā vacāmsi* IV.3.16. (12) *a*: We have here a reference to Indra's tactical transformations with the help of his Māyā; cf. III.53.8; X.120.6; or perhaps, this is only a Rūpaka, *vāra* being a bushy tail; cf. I.27.1a: 'You became a horse's tail' means you brushed aside your foes as easily as a horse drives away flies with his tail. *deva ekah* of course goes with *tvam* understood in *a*. *sykē* is either *sykka* (cf. IV.18.9) or Vajra (Sāyana). (13) Supply *sā api* in *b*; *siṣedha* from *śidh* (*sidhyati*). *aparibhyah*; Supply *rātribhyah*; cf. *aparīṣu* I.113.11; X.117.3; 183.3. (14) *yātā* is an avenger. This legend of Indra's running away through fear is not mentioned elsewhere in the Rgveda; but the Samhitas of the Kṛṣṇa Yajurveda allude to it now and then. c:cf. I.80.8; X.104.8. The rivers are those over which Ahi had extended himself and which were liberated by Indra's Vajra. The Śyena in the simile is very likely the one who brought the heavenly Soma to the

hawk ? (15) Indra, who places the Vajra in his arms, is the king of the moving and the resting (world), of the tame and the horned (animals). He alone surely rules over men as their king. He surrounds them (for protection) as a rim does the spokes (of a wheel).

33

(1) Come let us go to Indra, longing for the cows. May he increase his providential care for us. Will he the invincible god, immediately appropriate to himself our ardent desire for this wealth and cows ? (2) I run to the resistless Indra who is a giver of wealth, like a hawk to his accustomed nest, worshipping him with my best hymns—him who is fit to be called upon by the singers in a difficulty. (3) Followed by the whole of his army, he places the quivers on his body ; he drives out (from their stall) the cows of (any enemy) whose (cows) he likes. Commanding ample wealth, oh Indra, do not be a miser (in giving it), oh god grown great for our sake. (4) Moving all alone with your helpmates, you indeed killed the wealthy Dasyu with your club, oh Indra. They ran everywhere helter-skelter from their fort ; the Sanakas who did not offer a sacrifice, took to flight. (5) Those non-worshippers vying with the worshippers bent away even their heads, oh Indra, when forth from the heaven you (dashed), oh fierce rider and lord of the bay horses. You biew down the impious ones from the two worlds. (6) They sought to fight with the Host of the faultless Indra ; his men, the Navagvas, exerted themselves very hard. Being driven, they (*i.e.*, the demons) came away from Indra over the slopes, distinguishing themselves as impotent persons fighting with a mighty warrior ! (7) At the other end of the mid-region, you overpowered these, who were (first) laughing (and then) crying, oh Indra. You burnt down the Dasyu from the heaven high above. You protected the hymn of the worshipper, who presses the Soma and sings the praises. (8) These demons, enveloping the earth (with darkness)

earth ; cf. IV.26.5 ; IX.77.2. (15) *d* : cf. I. 141. 9*d* ; X.121. 10*b*.

33

(1) *asmākam sumatim* *i.e.*, *sumati* intended for us ; it belongs to the god and is sought for by the worshipper : Cf. III.57.6 ; X.23.7. *anānuṣṭa* 'one who cannot be killed' (from *anuṣṭa* 'to kill'), but who kills the Dasyus ; cf. IV.16.12 ; VI.44.17. *d* : *param ketam* : cf. I.146.3 ; X.136.6 ; also VIII.98.7 (*mahaḥ kāmān*). *d* : Will he work as though he himself longed for them ? (2) *d* : Cf. I.100.1*c* ; 101.6*a* ; IV.24.2*a*. *yāman* is a calamity, a danger etc. Cf. *mahe yāman* I.116.13. (3) *senā* is the host of the Maruts and the Angirases ; see v.6*a* below. *coṣkūyamāṇaḥ* (from *ṣku* 'to command') ; cf. VI.47.16 ; VIII.6.41. (4) The rich Dasyu is Vṛtra according to Sāyaṇa and this is probably correct (cf. v.4*c* with VIII.3.19 and v.6*c* with I.32.7). He had many followers who decorated themselves with gold and jewels (v.8) and who enveloped the earth and Indra's spies with darkness. But Indra dispelled the darkness with the help of the Sun and drove out the cows from the dark cave of the demon (v.8,10). He drove out the Dasyu and his followers from their home, with the help of the Angirases (vv.4-6,9). *b* : Upaśākas are the Maruts. *dhanu* is the home of the demon ; it seems to be a high table-land or a hill-fort as suggested by the adjectives *bṛhat* and *pravat* used of *dhanu* at I.144.5 ; VIII.3.19 ; X.4.8 ; 27.17. Sanakas are the ancient followers of Vṛtra, perhaps conceived as the early prototypes of the Panis. *pretim* 'flight, escape.' *viṣṇuḥ* from *viṣṇa* : 'in a disorderly way.' (5) *śīrṣā parāvṛjjuḥ* : 'turned away their heads ; took to heels.' (6) *b* refers to the Angirases. *c* : Cf. I.32.7*c*. *nirastāḥ* from *nir-ast*. (5) *cd* : Supply a verb in *c* and take *d* as the chief clause (cf. v.9*d* ; 10*d*). *sthātā* *i.e.*, of the Haris ; cf. VI.41.3*c* ; VIII.24.17*a* ; 33.12*d* ; 47.1*c*. For *d*, cf. v.9 and VIII.3.20 ; X.55.8. (6) *d* : *pravadbhir āyan* 'Came away over the slopes *i.e.*, ran down in great haste ;' See note on *pravatā vya* at JBBRAS., 1938, p. 37. (7) *rudato jakṣataḥ* : Really *jakṣato rudataḥ* ; but metrical rhythm caused the change of sequence. *rudatoḥ* : cf. X.67.6 ; X.99.5. (8) *c* : *him ānāsaḥ*

and themselves shining with gold and jewels, did not overpower Indra, though they urged themselves very hard. He (*i.e.*, Indra) surrounded his spies (on earth) with the sun's light. (9) When, oh Indra, you occupied both the worlds on all sides by your greatness, you drove out the Dasyu and his non-believing followers with the help of the priests who had full faith in you ; (10) The followers—who did not find the end of the heaven or of the earth, and who could not overpower the wealth-giving god by their wiles. (Against them) the mighty Indra chose the bolt as his companion. He brought out the cows from the darkness by means of light. (11) The waters flowed forth in accordance with his will and pleasure ; he grew powerful in the midst of these navigable waters. With a concentrated mind, Indra killed him by his most powerful weapon for all the days to come. (12) He pierced down the strong forts of Iḷibīṣa. Indra smashed the horned (*i.e.*, wild, ferocious) Śuṣṇa. You killed the enemy who sought to fight with you, by means of your bolt with as much strength and overpowering might as you possessed. (13) The victorious (bolt) conquered all his enemies ; with the fierce bull (*i.e.*, the Vajra) he (*i.e.*, Indra) battered down the forts. Indra brought Vṛtra into contact with his bolt and striking hard, fully carried out his own intentions. (14) You saved Kutsa, whom you loved, oh Indra ; you defended the Bull, Daśadyu, while he was fighting. The dust raised by the hoofs rose up to the skies. The son of Śvitrā stood up for battle. (15) You saved the tame Bull in the midst of Tugra's armies ; (you saved) that ox of Śvitrā, oh Meghavan, for the conquest of the fields. The enemies who stood here, lingered even for a long time ; you have lowered the possessions of the enemies, (when compared with that of your worshippers).

51

(1) Entertain with your hymns that Indra, who is often invited, who deserves our hymns, who is the ocean of wealth and who is that

i.e., *tanuam* ; cf. X.28.12 *d* : *spāśh* : the spies of Indra mentioned only here. But cf. IX.73.4-5 ; X.10.8*b*. For Sūrya's assistance cf. also II.11.4 ; VIII.12.9 ; X.138.3 ; 148.4. (9) *ab* : Cf. I.100.14*b*, *abhamanyamānān bhravatīḥ* : The Angritas are intended. For the adjective, cf. IV.20.5*c*. (10) *ab* is to be construed with *amanyamānān* in v.9*c*. *d* : *gāh edukṣat* : 'milked out *i.e.*, produced, brought out the cows.' The cows are of the Dasyu mentioned in vv.4 to 10. As a matter of fact the mention of the cows and the Paṇi in v.3 has led the poet to the present episode in vv.4-10. (11) *ab* refers to Indra and not to Vṛtra. For *a* cf. III.33.2,4,6. For *b* cf. X.30.4*d* ; 43.3*cd* etc. *abhi dyūn* 'for ever.' It is the same as *uttarān anu dyūn* at I.113.13*c*. (12) *syngīnam* (*śuṣṇam*) 'untamed or wild.' In *cd* supply *tena tapasā* or *balena*. (13) *a* refers to Vajra and *b* to Indra. *tigma vṛṣabha* is again the Vajra. Cf. VII.18.18*a* ; X.180.2*c* ; and II.16.6*a* ; X.99.11*b*. (14) *a* : Cf. I.171.5*a*. *b* : *vṛṣabham daśadyum*. This prince is probably the same as Daśoni and Daśasipra at VIII.52.2 ; see my note on VI.20.8. He was fighting against Tugra and his people and was saved by Indra. See VI.26.8. Vṛṣabha was perhaps his proper name and our poet indulges in a pun on the name. The word *tigma vṛṣabha* in v.13 reminds the poet of this *śama vṛṣabha* by contrast (v.15). He is also called a *gau*, son of Śvitrā (his mother?) vv.14-15). A Śvātreya king is mentioned even at V.19.3. According to Geldner both the Vṛṣabhas mentioned in v.13*b* and v.14*b* were real bulls trained for fighting. Our poet seems to make a difference between a *gau* and a *vṛṣabha*. The former signifies meekness. (15) *c* : The subject is *śatruṇyantaḥ*. *jyok kṛ* means 'delay, tarry' ; 'they lingered for a long time' means they died ; they did not get up at all. *vedana* (from *vid* to obtain) is 'property.' For *d* cf. I.101.5*c*.

51

(1) *ṛyam meṣam* : Cf. I.52.1 and VIII.2.40. *b* : *vasto aparacm* : Cf. *ākarc h vasoḥ* I.1.51.3 ; V.34.4 ; VIII.33.5 ; *ṛāyo avanīḥ* I.4.10 ; VIII.32.13 ; *utsam vasumaḥ* II.16.7 ; *utso*

famous goat. Praise that greatest poet for the sake of enjoyment, whose gifts being favourable to men move about everywhere like the days. (2) The skilful, active and helpful (Maruts) lovingly waited upon this Indra, who is possessed of good protective powers, who fills the mid-region, who is surrounded by great nights, and who rouses his own wud joy. A swift-working kindness has possessed the Śatakratu. (3) You flung open the cows' stall for the Aṅgirasas and you became the path-finder to Atri in places with a hundred (apparent) outlets. You brought wealth to Vimada together with food, making your bolt dance in the battle of the steadily living one. (4) You flung open the covers of the floods (and) supported the liberal treasure in the mountain. When you killed the Ahi Vṛtra with your power, oh Indra, immediately then you sent up the sun in the heaven for being seen. (5) You drove away with your supernatural powers the wily demons who gave offerings in their own mouths as they liked. You battered down the forts of Pipru, oh brave-minded Indra, and saved Rjīśvan in your slaughters of the Dasyus. (6) You saved Kutsa in the slaughters of Śuśna; you subdued Śambara for the Atithigva. You trampled under foot even the great Arbuda. You were born for the slaughter of the Dasyus even from very old days. (7) All sorts of physical strength are placed together in you; your bounty becomes favourably agitated (in favour of the poets), for the sake of the draught of Soma. Your Vajra becomes distinguished when placed in your arms. Cut down all powers of the enemy. (8) Know well the Aryans and also those who are the Dasyus. Ruling over them, subdue the lawless (Dasyus) to the sacrificer. Be the powerful impeller of a worshipper. At the sacrificial feasts I have loved (to recount) even all those deeds. (9) Subduing the lawless to the law-abiding (Aryan) and smashing the disloyal (Dasyus) with the help of the loyal (Aryans), you, oh Indra, (became) an ant when praised, (and) completely destroyed

hiraṇyayaḥ VIII.61.6. *c* : *mānuṣā* i.e., *casū* cf. II.23.9b ; VI.12.2d. (2) *ūtoḥ* (adj.): The Maruts are meant; cf. I.52.4; 9. *tarīṣṭhī* *āptam* : Cf. III.38.2, also v.7c below; III.31.13d ; IV.21.1c. *vāṇṛtā* : Cf. on I.30.5. *qbhava* is adjective of the Maruts. *madacyut* : Cf. VIII.22.16 (Aśvinā) ; Indra's horses (I.81.3 ; VIII.33.18), and Vajra (VIII.96.5), are also called *madacyut* ; similarly the *veg*, granted by the Maruts (VIII.7.13) and the gift horses of Daśaratha are so described (I.26.4). (3) *a* : Cf. V.29.12. *śataśreṣu* : Supply *yantreṣu* or *gheṣu* ; the plural is characteristic ; cf. v.5d, 6c. The reference in *b* is uncertain. From X.99.3 *śatadhva* would appear to be the name, or at least an epithet of a demon. Atri was perhaps left in the hundred-doored mansion of the demon without any guidance to come out of it. Indra came to his help, led him out of it and gave him the riches of the demon. The hundred doors of course must be understood to be only apparently so; hence the difficulty of finding out the real door. This may be another example of the *māyā* 'deceptive powers' of the demons. *cd* : Vimada is otherwise known as a protégé of the Aśvinā who secured for him a wife called Kamadyu, the *yoṣā* of Purumitra. Here Indra's gift to him is food, riches and permanent dwelling, (*avasāna*). For *d* cf. I.85.5b. *ahi* is the Vajra. (4) *a* : Cf. I.32.11cd ; IV.28.1d. *b* : The *dānumad* *vasu* in the Parvata is the rain-water in the cloud ; cf. I.54.7d ; V.31.6d ; 68.5b. *d* : Different gods are said to have placed the sun in the heaven ; cf. I.7.3 ; 32.4 ; 52.8 ; II.19.3 ; VIII.89.7 (Indra) ; X.156.4 (Agni) ; IX.86.22 ; 107.7 (Soma) ; X.65.11 (Viśve Devāḥ) ; IV.13.2 (Mitrā-varuṇā) ; X.62.3 (Aṅgirasas). (5) The wily demons are the followers of Pipru who was attacked and killed for the sake of Rjīśvan ; cf. I.53.8 ; 101.1 ; IV.16.13 ; V.29.11 ; VI.20.7 ; X.99.11 ; 138.3. *suptau* : The meaning of this word is uncertain. According to the Vedic tradition it means 'mouth,' *b* means 'who brought offerings to their own selves and not to the gods!' cf. Bhagavadgītā 3.13, and on 52.5 below. (6) *mahāntam* *arbudam* : Cf. II.11.20 ; 14.4 ; VIII.32.3 ; X.67.12. (7) *a* : Cf. III.31.13d, and on v.2 above. *b* : The draughts of Soma rouse Indra's liberality ; cf. I.139.6 ; III.51.12 ; IV.21.9 ; VIII.19.29. *śākin* : cf. I.54.2 ; VIII.46.14. (8) *d* : Cf. v.13d below. (9) *ramra* : Indra became a male

the forts of (that Dasyu), who though powerful was trying to be more powerful and reach the heaven. (10) Since Uśānā fashioned your power by his power, your strength holds apart by its greatness the two worlds. The horses of Vāta, yoked by prayer, carried you to your famous deed while you were being filled (with Soma-streams), oh brave-minded Indra. (11) When Indra rejoiced in the company of Uśānā Kāvya, he mounted upon the swift—nay, the swiftest—horses (of Vāta). The fierce god pushed out the fleeing (Śuṣṇa), as though he were forcing a flood of waters through a small hole. He smashed to pieces the forts of Śuṣṇa. (12) You mount upon your chariot for the sake of the draughts of the mighty. These latter, in which you feel delighted, are offered by Śāryāta. When you enjoyed the company of sacrificers who offer Soma, oh Indra, you mount upon (i.e., claim for yourself) a resistless praise in the heaven. (13) To the eloquent and elderly Kaksivān who pressed the Soma, you gave the youthful Vṛcayā. You became the wife of Vṛṣaṇaśva, oh wise god. All those deeds of yours deserve to be praised at the libations of Soma. (14) Indra is placed (among the Pajras) for the sake of an extravagant gift of the pious worshipper. Our hymn (is offered) to Pajras like a household sacrificial post. Seeking horses, cows, chariots and riches (for his worshippers), Indra alone is the lord of riches and gives it. (15) This hymn is sung to the mighty, self-radiant and strong Indra of unfailing strength. May we, surrounded by all our warriors, be well under your protection together with our patrons, in this calamity, oh Indra.

ant and brought down the (wooden?) walls by eating up into them. *saṁdīhaḥ*: Cf. *dehyaḥ* VI.47.2; VII.6.5. (10) *sahas* of Indra is his Vajra; cf. I.52.7cd; *ā pūryamānam*: i.e., by the Somas; cf. V.34.2; also II.14.10b; *vātasya man.oyujah*: They are called *vanhu* and *vanhutara* in the next stanza; also cf. VIII.1.11; *śrataḥ* is a famous deed. (11) *uśane* is an irregular locative. *c* contains an ill-expressed simile which suggests the great force with which the demon was chased out of his home by Indra. *yayī* is an adjective of Śuṣṇa as it is of Rudra at X.92.5. Śuṣṇa is compared with a big mass of water which is forced out through a small hole. Cf. in particular *nir arta* at IV.16.9b. Releasing of the water-floods in themselves does not play a part in the Śuṣṇa legend. (12) *vṛṣapāṇeṣu*: Supply *induṣu* and cf. I.139.16. The loc. is Viṣaye Saptamī. *prabhṛtāḥ*: Supply *vṛṣapāṇūḥ* from *a*. Cf. II.36.5 (*sutaḥ ābhṛtāḥ*). *d*: *ślokaṁ divi*: Cf. I.83.6c; 92.17a. *ślokaṁ āruhat*: Cf. *vājam āruhaḥ* IX.83.5c; *ā rohata āyuh* X.18.6a. (13) *ab*: This exploit of Indra corresponds to that of the Aśvinā who brought a youthful wife to Vimada. *c* is very peculiar; Indra transformed himself into a woman for one of his worshippers; elsewhere we are told, he became a cow or a horse, if necessary, for his friends: cf. VI.45.26. *menā* is the same as a *jani* as is clear from *amenāmś cit janivataś cakartha* V.31.2d. *vṛṣaṇaśva* is a proper name; cf. *vadhryaśva*. To Kaksivān he gave a wife; but for Vṛṣaṇaśva, he himself became one. Geldner tries to interpret our passage in view of I.121.2cd and X.111.3c. But the two are essentially different; in our passage *menā* is nom. and used with the root *bhū*; while in the other two passages it is Accu. and used with the root *kṛ*. The distinction is clearer in X.111.3c: There, Indra *did* something to the *menā* and *became* something of the *gau*. His suggestion that *vṛṣaṇaśva* may have signified a being half bull and half horse is fantastic, so far as the R̥gveda is concerned. The word means as said above 'one whose horses are powerful' as against *vadhryaśva* 'one whose horses are impotent.' *d*: Cf. VIII.100.6a; also IV.22.5ab and VIII.62.3. (14) *pejreṣu* is to be understood in *a* and *aśrāyī* in *b*. *sudhī* is a pious worshipper, here the leader of the Pajras. *nireka* is an extravagant, bottom-reaching gift. *nirke* is a Loc. of purpose. *duṛyo yūpaḥ* is a sacrificial post erected just in one's own house, and not outside say, on the bank of a river, etc. (Cf. Raghuvamśa, I.44: IX.21). Indra and Stoma are compared with such a Yūpa. But what is the point of comparison? Decoration, or careful approach is possible meant. Geldner's explanation 'das halt so fest wie der Turpfosten' is inadmissible, as *yūpa* in RV. does not mean an ordinary pillar. *vamśa* is the word or it. See I.10.1 and note. I construe *c* with Indra, and compare VII.31.3. (15) *vṛjane*: Cf. VI.68.3d: X.28.2ab.

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(1) Glorify that famous goat who wins the sun's light and whose hundred well-born (favours) go together (to the worshipper). May I turn hereward for a favour with my good hymns that Indra (and his) chariot which runs to a call for help, as a horse runs to a prize. (2) That Indra, whose favours are thousandfold, who is immovable like a mountain in his strong foundations, grew mighty in the midst of his powers, when, filled with wild delight by the gladdening drink, he killed Vṛtra who lay blocking up the rivers, pressing forward the floods of waters. (3) He indeed is a destroyer among the destroyers, a deep hole at the udder (*i.e.*, the Soma stalk), (a treasure) possessed of a bottom of gold, invigorated with the intoxicant Soma (offered) by the sages. With my pious work and hymn I have invited that Indra whose gifts are greatest. For, he always fills himself full with the blinding drink. (4) In his Vṛtra-slaughter, his protective powers and resistless might (viz., the Maruts) whose form is unbent, wait upon that Indra, whom his own well-born succours (*i.e.*, the Somas), enjoying a grass-seat, fill well, in the heaven as rivers do the ocean. (5) The protective powers of him who was fighting with the self-showerer in the wild joy of this (Soma), ran swiftly to him like swift (racers) on a sloping ground, when the wielder of the bolt, emboldened by the gladdening drink battered down (the head of Vṛtra) as Trita smashed the surrounding walls of Vala's cave. (6) Excessive heat surrounded him; his strength blazed forth. He (*i.e.*, Vṛtra) lay at the bottom of the regions blocking up the waters, when oh Indra, you hurled your bolt at the chin of Vṛtra who was difficult to seize over the sloping regions. (7) These hymns which glorify you (and) the juices, oh Indra, run down to you like wavy streams to a big lake. Even Tvaṣṭā increased your strength which is your bosom friend (and) fashioned the bolt of

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(1) *a* : Cf. I.51.1a. *b* : Cf. I.51.1c. Supply *abhiṣṭayaḥ* (cf. v.4). The simile in *c* is pretty clear though awkwardly expressed; Indra's chariot going to a call is compared with a horse going to a staked prize. *syadam* expresses the common property, but it is compounded with the secondary Upamāna. (2) Dharuṇas of the Parvatas are the firm rocky foot-hills; *taviṣṭu* : Cf. on I.51.2. (3) *dvara* from *√dṛ* = *vr* to oppose; cf. *vrka-dvarasam* II.30.4. *ūdhan* is the Soma-stalk looking like the udder of a cow and yielding the milk-like juice. Indra is a *vavra* in respect of Soma; but not in respect of waters like Vṛtra, who is called *asiva vavra* 'insatiate hole' at V.32.8. Supply *nidhiḥ* after *candrabudhnaḥ*; cf. X.108.7. *candra* is gold; cf. II.2.4; also cf. *candracē rūdhe* III.30.20; V.57.7. *su-apasyā* is good pious work; a worshipper is called *su-apas* at I.130.6; V.2.11; 29.15. (4) *svā abhiṣṭayaḥ* are the Somas. *sadma-barhiṣaḥ* : (Bahuvrihi with Paranipāta of *barhis*) : 'those who enjoy a seat of grass'; *i.e.* are placed on the *barhis* as a sacrificial offering. *samudram na* : Supply *sindhavaḥ*; cf. III.46.4; VI.36.3; VIII.6.35; 49.3; 92.22; IX.108.16. Also v.7. below. *ūtayaḥ* and *śuśmāḥ* are the Maruts; cf. v.9 and I.51.2; *ahrutapsavaḥ* is an adj. of Maruts even at VIII.20.7c. (5) *svavṛṣṭi* is Vṛtra; the word is evidently intended as the object of *yudhyataḥ*; cf. v.14c and VI.3.3ab; 39.2d; X.8.8. *svavṛṣṭi* 'one who showers all foods including Soma in his own belly' is like the *kevalādi* at X.117.6; also cf. I.51.5b above. In *d* supply *vrtrasya śiroḥ*; cf. v.10 below and IV.18.9; VIII.6.6; 76.2. Trita's smashing of Vala's cave is introduced as a simile (cf. X.8.7-8). As a matter of fact, Vṛtra's slaughter is the main theme of the hymn, as seen from vv.2,4,6,8,10,15. No other demon is mentioned. (6) *a* refers to Indra; *b* to Vṛtra. *titviṣe śavaḥ* : cf. *titviṣe ojaḥ* VIII.6.5 and *tvaṣṭarmanāḥ Indrah* X.120.1. *pravane durg-bhiḥ śvanāḥ* : Cf. VI.46.14a; VIII.103.11c. *d* : Cf. v.13 below and I.56.6d; X.152.3b; on the other hand, at IV.18.9 Indra's *hanū* is described as wounded by Vṛtra. (7) *ūrmayaḥ* is double-meaning : It means 'streams of Soma' on the one hand and the 'streams of rivers' on the other. For the simile cf. III.45.5d; VI.47.14; X.43.7. *b* : Cf. I.10.5; II.12.14; VI.23.5,6; VII.22.7; VIII.62.4. *yuyom śatāḥ* perhaps stands in apposition to *vajram*; cf. VI.21.7. *gātūyan apah* : Cf. VI.30.3b; VII.47.4b. Also cf.

overpowering might for you. (8) Oh Indra in whom wisdom is well collected, when you killed Vṛtra in the company of your horses, seeking to give an outlet to the waters for the sake of man, you held the bolt of steel in your arms. You supported the sun in the heaven for being seen. (9) (Indra performed) a mighty self-attractive and powerful (deed) which was praiseworthy, (when the gods) accomplished their climb to the heaven through fear, (and) when the Maruts, his help-mates who are loyal to the hero and whose fights are favourable to men, rejoiced in Indra and the sunlight (won by him). (10) Even the mighty Dyau moved back in terror from the roar of Ahi, when, with great force and in the wild joy of the juice, your bolt oh Indra, broke the head of Vṛtra who had blocked up the two worlds. (11) Even if the earth were ten times vaster and the people had continually multiplied (on it), still even here, among all these, would your famous might spread itself with force and vitality, by the side of the heaven. (12) (Coming) from the heaven lying beyond this region for a favour, you of self-reliant vigour, oh bold-minded Indra, have made the earth the counter-measure of your strength. Having full mastery over the waters and the sun's light, you come back to the heaven. (13) You became the counter-measure of the earth; you became the lord of the vast (heaven) whose heroes (*i.e.*, the gods) are noble. By your greatness you filled completely the entire midregion.

III.33.6. *c* : *vajram āyaśam* : cf. I.80.12; 81.4; VIII.96.3; X.48.3 : 96.3; 113.5, *d* : cf. on 51.4d above. (9) I supply *sah vīryam akṣṇot* in *a* ; and *devāḥ* as the subject in *b*. The poet here intends to contrast the behaviour of the other gods with that of the Maruts and Viṣṇu as at IV.18.11 ; VIII.96.7. I think the poet first intended to use *akṣṇot* in *b* ; but suddenly he changed his mind and put a form of that verb which was appropriate for the gods about whom he intended to say something. The result of this manipulation was the dropping of the verb in *a* and of the subject in *b*. That the poet had Vṛtra's slaughter in his mind when he composed *a* is also clear from v.15 below and I.103.7. For *yad ukthyam* cf. II.13.1d ; II.23.14c ; IV.36.4d ; VIII.99.2cd. *b* : Cf. VIII.93.14b. *mānuṣapradhanāḥ* : *pradhana* is either a fight or a treasure. *indram* and *sva* are the objects of *anu amadan*. *sva* is perhaps mentioned owing to the influence of v.8d. (10) There is no doubt that *te vajrah* in *b* is the subject of *abhinat* in *d* ; cf. I.80.12 ; III.30.6. Also see VIII.6.6 ; 76.2 ; and on v.5d above. I do not agree either with Oldenberg who construes *vajra indra te* as a part of the 1st sentence ('Even the Vajra of yours, oh Indra, moved back'), or with Geldner who takes *vajra* as equal to *vajre* against Padapātha ('Even the heaven moved back for your Vajra, *i.e.*, to make room for it'). For the idea in *a* cf. I.80.11 ; IV.17.2 ; V.32.9 etc. The accent of *rodasī* (voc.) in *c* is doubtful ; cf. VII.69.1. But it is possible that the poet here makes an appeal to the *rodasī* (voc.) to testify to what the poet has said about *Dyeu* in *a*. Two vocatives in the same sentence as at I.6.3. So translate :—When your Vajra, oh Indra, broke the head of Vṛtra who blocked (you) up, oh Rodasī, in the wild joy etc. (11) *daśabhujīḥ* is 'encompassing ten times as many people as there are on it at present' ; cf. *śatabhujīḥ pur* I.166.8 ; VII.15.14. *viśvā ahōni* is accusative of time, as at I.171.3d ; VII.25.4c. *tatananta* (Subjunctive) *kṛtavyaḥ* : Cf. I.166.14c. The idea is : Even if the world were ten times bigger and the people were to multiply for ever, Indra's power would be able to reach them both completely like the heaven. *anu bhuvat* (Subjunctive) : cf. *viśvam anu pra bhūtā* VII.77.3d ; VIII.58.2b. According to Oldenberg and Geldner, the stanza contains a statement of fact and not a supposition : 'So soon as the earth became ten times vaster and the people spread themselves for all the time, your famous power became comparable with the heaven by its might and self-reliance.' But the particles *nu* and *it*, the real vastness (and not mere metaphorical one) suggested by the adjective *buji* of the earth, the sense of a future-tense for the word *tatananta* as suggested by passages like IV.5.13d ; VII.88.4d ; X.37.2b and the emphatic assertion by the words *atra aha*, all leave an impression that we have here to do with a supposition as in the Śivamahimna Stotra, v.32. (12) Supply *āgatya* in *a*. For *c* cf. v.13a and I.55.1ab ; 102.8ab ; X.111.5ab. In *d* perhaps even *dīvam* is to be construed as the object of *varibhūḥ* like *apah* and *sva* ; cf. v.13b :—'you comu (to us), having full mastery etc.' (14) *b* : *rajasah* : The regions over which you rule ; the rivers are ceaseless travellers and yet they would not be able to get at the

It is quite certain that no one else is like you. (14) All alone you make everything else dependent on you, whose vastness the heaven and the earth cannot comprehend and the end of whose regions the rivers are unable to reach and particularly so, when you fight with the self-showing (Vṛtra) in the wild joy of this (Soma). (15) The Maruts sang praises in that same battle and the Viśve Devas rejoiced in your company, when you struck the face of Vṛtra with your weapon furnished with sharp edges.

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(1) We indeed lay down this hymn, these prayers, for the mighty Indra at the house of the priest. For, at any time of the day, he obtains the wealth of the (enemy) like that of sleeping men. A bad hymn is not praised among the patrons. (2) You are the conqueror of a horse (and) a conqueror of a cow, oh Indra. You the mighty lord of riches are the winner of corn. He is the helper of men from very old days and a friend who never frustrates the desire of his friends. Him we praise, here (in this hymn). (3) Oh powerful Indra, oh most glorious performer of many deeds, all this wealth here is known to be yours. Having well seized from it, bring it to us, oh overpowerer; do not leave the desire of your loyal bard unfulfilled. (4) (Be) glad at heart in these days owing to these juices, removing our poverty by means of cows and (wealth) consisting of horses. Overthrowing the Dasyu through Indra by means of the juices, and freed from the feelings of hatred (of our rivals), may we be associated with plenty of food. (5) May we be associated with wealth, oh Indra, with food and with rewards which are very pleasant and bring us fame. May we be associated with divine providence which has its strength in brave sons, which is prominent by means of cows and is full of horses. (6) Those wild joys, those powers and those Somas intoxicated you in battles, oh good commander, when for the sake of your bard and for him who offers you a grass-seat, you killed ten—nay, thousands of—matchless

end of the regions over which Indra has his sway. *na uta* emphasizes the vastness and dominion of Indra, especially when he fights with the nonsacrificers in the wild delight of the Soma. (15) *d*: Cf. on vv.6ed and 9 above. *bhr̥ṣṭimatā vadhena* i.e., by the Vajra which is *sahasrabhr̥ṣṭi*; cf. I.80.12; 85.9; VI.17.10; also V.34.2d.

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(1) *vivasvataḥ*: See note on III.34.7. In *c* Indra is the author of *avidat* and *nū cit* is positive. *c* gives a reason why Indra can afford to be a great and liberal donor. *d* gives a reason why a good hymn must be chosen for Indra, who is a Dravinodā. For *d*, cf. II.33.4ab; VII.32.21a. Geldner thinks that a human worshipper is the subject of *avidat* and *nu cit* is negative:—'Never has any one obtained wealth like (a thief) from sleeping men', i.e., without efforts.' So we must make efforts to get riches. But the simile *śasatām iva* rather suggests the *helpless* enemies who cannot prevent Indra from taking away their wealth: cf. I.33.3ab. Besides the root *śas* is often used with an enemy or devils; cf. I.29.3-4; 124.10; VI.20.13; VIII.97.3. The chief idea in the hymn again is that Indra should take away any body's wealth and give it to us (vv.2,3,4). (2) Indra's liberality is further praised. *inas patih* (two words); cf. X.26.7; *ina*, *inatama* is often used of Indra. *durah* (adj.) from *√dr* to break open. *sikṣanarah* like *radavasuh*: cf. IV.20.8c. *akāmakarṣanaḥ*: cf. v.3d; I.57.5b; III.33.3d: *idam* is an adverb as in v.7: 'here; just now.' (3) *c*: Cf. III.54.15cd. *d*: *ūnayih* is Optative 2nd sing. of the Denom. from *ūna*; cf. *anūnā yasya dakṣiṇā* VII.27.4c. (4) Supply *bhava* in *a*; cf. IV.3.15a; VII.28.4a. *amati* is 'want of *mati* which is the same as *pramati*'; so *amati* is want of providence, or poverty. For *mati* in the sense of providence cf. VII.37.2d: 100.2c. For *b* cf. X.42.10ab. *aśvainā*: supply *rayinā*; cf. X.122.3; also *aśvinam rayim* V.4.11; VIII.6.9; IX.4.10. *yutaedveṣaḥ*: Cf. *yavaya dveṣaḥ* VI.46.12; VII.77.4. *d*: Cf. v.5 and VIII.32.9. (5) *d*: cf. I.92.7cd; 169.8b; II.1.16ab; VI.39.1d. (6) *apratī vṛtrāṇi*: Cf. VII.

enemies. (7) You boldly meet a challenge with a challenge; you batter down with force the strong fort (of the enemy) with your fort (-like bolt), when with Namī as your companion, you killed the wily demon called Namuci in the farthest regions. (8) You killed Karāṇja and Parnaya with the sharpest rim of Atithigva's chariot-wheel. Never yielding your place (to your enemy) you smashed the hundred walls of Vṛṅgada, which were besieged by Rjīṣvan. (9) (Allying yourself) with the friendless Suśravas, you the famous one, killed the twenty attacking petty chiefs and their sixty thousand and ninety nine followers with a chariot-wheel which had a wicked kick. (10) You protected King Suśravas with your favours, King Tūrvayāna with your defending powers, ḥh Indra. You subdued Atithigva Kutsa of the Ayu family for this mighty youthful king. (11) May we, who would be your most pious friends enjoying gods' protection at the completion of the sacrifice, praise you, being begirt by brave sons and possessing long and glorious life through you.

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(1) Do not (neglect) us oh Maghavan, in this danger in battles. For, the end of your might cannot be fully reached. Thundering (like a lion), you caused the rivers and the trees to shriek. How have the people not gathered together out of fear (when you perform your exploit)? (2) Sing to the mighty Śakra endowed with powers. Glorifying Indra who listens (to our praise), praise him, who the mighty Bull, subdues the two worlds with his undaunted strength and bull's might. (3) Sing this powerful hymn to the mighty Dyau, the mind of whom, the bold one, is dauntless and self-strong. The far-famed Asura (i.e., Indra) was fashioned (by him) with might. He, (i.e., Indra) is indeed a powerful

23.3; IX.23.7. Or take *apṛati* as an adverb; cf. VII.83.4; 99.5. *barhiṣmate* i.e., *yajurmadhūya*; cf. I.51.8; V.2.12; or, *kāraṇ* in *c*; cf. *ṛṣibhiḥ barhiṣmadbhiḥ* VIII.70.14. (7) *yudh* and *pur* are both fem. nouns and *idm* is an adverb (here, at this time) as in v.2d above. The neu. *para* is unknown to the Rgveda. *parā* (instr.): The Vajra is meant. It is identified with a defending wall. *cd*: Cf. VI.20.6; X.48.9. For Namuci see note on V.30.8. (9) *ab*: Cf. X.48.8. *vartanī* is the wheel-like weapon; see below on v.9. *pariṣūṭāḥ* from *pari* and *śu* to order; cf. *pariṣūṭiḥ* (counter-commander) I.119.6; IX.85.8. For Rjīṣvan cf. on I.51.5 above. Vāṅgrda is either Pipru himself or an ally of his. (9) Janarājas are mentioned only here. They attacked Suśravas who was without an ally. *duṣpadā cakreṇa*: 'With a chariot wheel which had wicked feet (i.e., sharp iron claws or edges with which the rim of the wheel was furnished and on which it rested as on feet).' The chariot wheels or weapons having a form like them were often used in ancient India in warfare; cf. II.34.9; V.52.9; VI.8.5; VIII.96.9; X.180.2; also cf. *pariṣūṭā* *ṣṣurā* *adhi* I.166.10 and *vartanī* in v.8 and VIII.63.8c. (10) *kutsam atithigvam dyum*: All the three appear to be the names of one and the same person. Tūrvayāna was defended against this prince of the Ayu family. Cf. II.14.7abc; VI.18.13. (11) *udṛchi*: Supply *yajñe* and cf. IX.77.7a.

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(1) Supply *parā* *vark* in *a*; cf. VI.59.7; VIII.75.12. *śavasah antaḥ*: cf. I.100.15ab; VI.29.5ab (see note); VII.21.6d. *roruṣat* is an adjective of Indra; *nadyah* and *vānā* are the objects of *akṛādayah*. When Indra performed an exploit he thundered like a lion and caused the whole world to shriek with fear: Cf. VIII.51.4; IX.97.13; also IX.68.2ab. *d*: *ṛṣibhiḥ*: 'people' in general; cf. 57.4 below and I.173.7. The question in v.1d expects a positive answer. 'Yes; they must have clung together through fear.' (2) *nī ṛñjate*: Cf. I.143.5d; IV.26.1c. For *cd*, cf. VIII.15.2. (3) *a* refers to Dyau; *b* to Dyau or to

chariot placed before themselves by the two bay horses. (4) You caused the top of the mighty heaven to tremble ; you indeed, boldly dashed down Sambara, when in an undaunted manner you attacked with your jubilant (Vajra), the sharp bolt in the form of the claws of that wily demon who was gradually sinking. (5) Who can oppose you even if you do today what you (formerly) did, when with a bold and confident mind you thundered and smashed down the trees on the head of even the panting and sinking Śuśna ? (6) You favoured the brave Turvaśa and Yadu as also Turviti and Vayya, oh Satakratu. You saved the chariot (of) Etaśa, when a rich prize was to be won. You battered the ninety-nine forts (of Sambara). (7) That person may surely become a leader and a king and grow powerful, who gives offerings to Indra and obeys his command, or even supports the hymns (of a poet) by means of a liberal gift. The helpful gift of the heaven swells for him. (8) May the royal power (of the patron) be matchless and may the hymn (of the poet) by unequalled. May the few Soma-drinkers be pre-eminent by their work, who by giving you offerings increase your great dominion and steady might, oh Indra. (9) These ample draughts pressed by the stones and resting in the tubs are surely meant for you, (oh Indra), as they are a special drink of Indra. Enjoy them, satisfy your desire for them ; and then make up your mind for a special gift of riches. (10) The darkness has shot up everywhere, destroying the strongholds of the waters. The mountain stood hidden in the belly of Vṛtra. Indra completely smashes all the followers whom the encompasser of the river had placed at the slopes (of the rivers). (11) Bestow on us glory which increases happiness, great dominion and strength which overpowers men, oh Indra. Defend us and protect our rich patrons and set us down for wealth and food associated with good progeny.

cf. IV.17.4ab ; VI.19.1cd. Dyau is conceived as the father of Indra. In *d* Indra is identified with a *ratha* as at VIII.33.4. Both Oldenberg and Geldner take the whole stanza as referring to Dyau ; but this is not convincing. Dyau is here praised as the worthy father of Indra as at IV.17.4 and not 'to make amends for the slight reproach of Dyau conveyed in v.4a.' (4) *a* : Cf. V.60.3b. *b* : Cf. VII.18.20b. *vṛandīnah* (from *vṛad*) : Cf. *avradanta vīlītā* II.24.3. In *d* the demon's *gabhaśti* is identified with *aśni* and hence the fem. *śītām. manūinā* i.e., *vajreṇa* (I.121.12). (5) *ni vanā vṛnakṣi* : The trees are, possibly the wooden shelter under which Śuśna temporarily hid himself. Geldner compares the *vārkaśa durga* mentioned by Manu, 7.70. *śvasanasya* : Cf. *śvasantam* V.29.4d ; VIII.21.11b ; *śāśvasato* X.48.6. (6) *a* : The two princes were helped to cross a river without dipping their bodies in water ; cf. I.174.9cd ; II.15.5b ; IV.30.17 ; V.31.8ab ; VI.45.1. *b* : Cf. I. 61.11 ; II.13.12ab ; IV.19.6a ; a river was stopped from flowing for this pair. *c* : There appear to be two Etaśas ; one a human sacrificer (I.61.15cd ; II.19.5) and the other the leading horse of the sun's chariot. Both are connected with the sun ; but the horse belongs to the Kutsa-Śuśna legend, while the human worshipper was possibly a racer, or a fighting warrior. Etaśa in our passage is possibly the latter. The reference in *d* is to the forts of Sambara. (7) Cf. IV.50.7-9 ; V.37.4-5. *śūśwat rāṭahavyah* : Cf. II.25.1b. *ditō dānūh* in *d* is the rain ; cf. I.51.4 ; VIII.25.6 ; X.43.7. *abhigṛṇāti rāḍhasā* : Cf. I.48.14c ; 140.13a ; V.27.3cd ; VII.81.5c. (8) *daduṣaḥ* is either genitive sing. or irreg. nominative plural ; so either an adjective of *te* or *ye*. *pra santu* : Cf. III.59.2a ; VIII.10.4ab ; also I. 150.3 ; VII.41.3. (9) *camasāḥ* : lit. cups, here, their contents. *eṣām kāmam* : Cf. *asya kāmam* III.48.2 ; also *vasuḥ kāmam* II.15.4. (10) The Dharuṇas of the waters are the Parvatas. Vṛtra enveloped them both and kept his followers at the slopes to prevent the rivers from flowing. Indra killed them all. (11) *sevṛdham* is irregularly formed from *śava* and *vṛdham*. With the root *dhā* the object is put in the accus. and the person in the loc. ; or the object in the dative and the person in the accus. *janāśāt* is either an adjective of *kṣatram* or of *tvam* understood. *c* : Cf. X.61.22b. *maghonah* adjective of *sūrin* ; cf. II.8.4a ; X.81.4d ; also I. 73.5. *d* : Cf. *svapatyam rayim* II.4.8 ; VII.1.5 : *svapatyāya rāye* IV.2.11. Our *svapatyāi* is a short form of *svapatyāyas*, adj. of *iṣe* and *rāye* both feminine forms.

55

(1) His vastness has spread itself everywhere more than that of the heaven itself. The earth is no match for Indra in point of greatness. The fierce and mighty god who is the tormentor of men sharpens his bolt as a bull (sharpens his horns), for pointedness. (2) He receives in himself by means of his vastness (the streams of Soma and the hymns) offered in many places, as the ocean does the rivers flowing in different places. Indra behaves like a bull for the draught of Soma ; that fighter is praised for his might from very old times. (3) You rule over the laws of great heroism as you master the mountain for the sake of nourishment, oh Indra. He is pre-eminently distinguished among the gods by his might ; the fierce one is placed in the forefront for all deeds of valour. (4) Proclaiming among men his Indra-like benign power, he alone is praised by the respectful (sages or trees) in the forest. The bull is amicable, the bull is loving, when he sets in motion the stream for the sake of peace. (5) He, a great fighter, causes great battles for men, by his power and greatness. And immediately then do they believe in Indra who is furious and repeatedly sends down his deadly Vajra (against them). (6) Growing in might, razing the artificial homes (of the Dasyus) to the ground, (and) recovering the benevolent luminaries for the worshipper, he the wise seeker of fame, released the waters to flow freely. (7) May your mind be inclined to a gift, oh drinker of Soma. Bring your horses here-ward, oh hearer of a prayer. Your impatient longings (for our Somas), which are your best guiding charioteers, do not harm you in any way, oh Indra. (8) You hold exhaustless riches in your hands ; the famous (Indra) possesses resistless power in his body. Many are the wise counsels in your limbs, well covered like deep wells by their diggers, oh Indra.

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(1) This impetuous (sacrificer) has sent forward, downward and upwards to him (*i.e.*, to Indra) his many (hymns and) draughts of Soma

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(1) *b* : Cf. I.52.13a ; VI.30.1d ; VIII.64.2c ; IX.119.7ab. *c* : *carṣanibhya ātaphuḥ* ; Cf. *kṣobhanāḥ carṣaninām* X.103.1b. *d* : *tejase vanśaṣaḥ* with *śṛṅgā* supplied is the Upamāna : cf. V.2.9d ; VIII.60.13ab ; IX.5.2c ; 70.7ab ; 87.7c ; X.103.1a. (2) *a* : This is a very common simile in which Indra is compared with the ocean and the hymns and the Somas with the rivers. Usually however, it is expressed the other way round : 'As the rivers go to the ocean, so do the juices and hymns go to Indra.' *samudriyaḥ arṇavaḥ* Oceanic mass of water. *viśritāḥ* : Supply *giraḥ* ; cf. I.117.1c. The word is also intended to be construed with *nadyaḥ*. *varimabhiḥ* : cf. *varimā* in v.1 and *varobhiḥ* in X.89.1. The plural shows extreme vastness. (3) *irojyasi* governs the accusative in the Upamāna Vakya and the genitive in the Upanēya Vakya. Parvata is the mountain-like rain-cloud. Its being a source of nourishment (*bhojas*) is often mentioned in the Rv. ; cf. I.65.5 ; VIII.49.2 ; 50.2 ; 88.2 etc. See also I.57. 6a. *nr̥ṇasya dharmāṇi* are the laws, rules, properties, etc. of heroism. *c. pra ati cikite* : is pre-eminently known as superior. (4) *vane namasyubhiḥ* : Either the bending trees are meant or the forest-living sages. In the latter case a contrast is meant between *janeṣu* and *vane*. *dhenām* is the sustaining stream, either of milk (Soma mixed with milk) or of eloquent praises. For the association of *dhenā* and hymns, cf. VII.24.2c ; X.104.3c. *kṣemena* like *avasā* : 'for the sake of welfare.' (5) *ab* : Cf. IV.42.5 ; VI.18.2 ; 35.2 ; VII.20.3 ; X.27.2 ; 125.6. *cd* : Cf. II.12.5 ; IV.24.4. *janebhyḥ* are the same people as are meant by *janeṣu* in v.4. Indra's benevolent side is described in v.4 and the malevolent one in v.5. (6) *kṣmayā* : cf. V.84.3b. *avrkāṇi jyotiṃṣi* are the benevolent luminaries namely, the Sun, the Dawn, the stars and the fire ; cf. X.36.3c. The reference in *c* is to Vala and that in *d* is to Vṛtra. *sārathi* is a charioteer, a guide. *bhūrṇayaḥ kutāḥ* : Cf. III.60.7c. (8) *a* : Cf. I.176.3 ; VI.45.8. *b* : Cf. II.16.2 ; VIII.96.3.

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(1) I take *bhurvaṇi* to mean a sacrificer (from *√bhur*) and compare I.50.6 ; I.19.4 ; 155.5 etc. Further, I supply *ayamsta* after both *pra* and *ava*. *pūrvīḥ camriṣaḥ* are the same

as (an impatient) horse rocks a lovely bride on its back. He makes him drink the active and skilful (Soma) for the sake of a great gift, having turned towards himself his golden chariot yoked with horses. (2) The hymns which bring the Soma offerings with them and surround him, (mount upon him) as (rivers) which seek to win prosperity (for man) in their movement, (enter) into the ocean. Mount upon the lord of strength, who is indeed the might of the sacrifice, with your lustre, as the loving (Somas) mount upon a mountain. (3) In point of manly strength he is a great victor, without raising any dust. Like the edge of the rock, his might shines brightly by its sharpness, through which, in the wild delight (of Soma), the invincible iron (Bolt) put the wily Śuṣṇa in fetters, in the midst of his followers. (4) When the divine might which grows great through you, clings to Indra for protection, as the sun clings to the Dawn, that god who drives away darkness with his bold strength and who shouts out for cheering up, raises the dust mightily. (5) When you mightily spread out the unmoved region, the support (of the heaven), you fixed it on the farthest gates of the heaven; you forced out the flood of waters when in a battle for sunlight, you killed Vṛtra in the wild joy (of Soma) and in the war-excitement. (6) You, oh Indra, being great, have mightily fixed the support of the heaven on the seats of the earth. In the wild joy of the pressed juice you released the waters. You evenly cut down the jaws of Vṛtra.

as *gūrtayah neman-iṣaḥ* in v.2. They are the hymns accompanied by draughts of Soma. *camriṣaḥ* from *cam* and *iṣaḥ*. *neman* is an irregular present participle of the root *nam*. *atyā na yoṣām* : An unusual simile; most scholars (including Sāyaṇa) take *yoṣā* to mean a mare. But the word is nowhere else used in that sense. So I suggest:—As an impatient horse (*bhurvāṇiḥ* to go also in the simile) sends forth, up and down the lovely bride (*yoṣā*), who rides on his back in a bridal procession, so does the worshipper send forth, up and down, i.e., wherever Indra might be, his hymns and offerings. For such an *atyā*, i.e., a horse in a bridal procession, cf. *janayā śulhā* at IV.38.6. The prayers and offerings, especially the former, are very often compared or identified with brides offered to Indra by the worshipper; cf. among others III.39.1-2; VIII.2.20 etc. *c* : *dakṣam* i.e., *somam*; cf. IX.61.8; 62.4; 76.1 etc. *mche* : Supply *rādhasē*; cf. I.139.6; VIII.24.10; 45.24. *pāyayate* : the subject is *bhurvāṇiḥ*. Cf. *pāyaya* I.125.3c. *hiraṇyayam* undoubtedly goes with *ratham* (in spite of Oldenberg, I.p.56), but *rbhasam* very likely with *dakṣam* (cf. IX.86.5). (2) Supply *adhi rohanti* in *ab*. Compare VI.34.3 for the idea. For *b*, see Similes of the Vāmādevas, No. 145 (JBBRAS., 1938). *cd* is addressed to Soma. *vidathasya sahaḥ* : cf. *adhvarasya peśaḥ* VII.42.1. *girim na venāḥ* : Cf. V.36.2; IX.36.6. (3) *areṇu mahān* : 'great without raising the dust' i.e., without even fighting a duel. For the *reṇu* raised in a duel, cf. I.33.14c; IV.17. 13b; 42. 5d; also cf. next verse and *bṛhadreṇuś cyavanāḥ* VI.18.2. *giriḥ bhṛṣṭiḥ* : Like the words *adri* and *parvata*, here perhaps *giri* means Vajra as is suggested by the word *bhṛṣṭi*; Vajra is *bhṛṣṭimat* and *sahasrabhṛṣṭi*. *tuj* is 'pressing fervour.' 'By sharpness his strength shines like the edge of the Bolt.' In such passages *na* has almost the sense of conjunction, since both the bolt and strength are *prakṛta* or relevant. *yena* i.e., *śavasā āyaso* i.e., *vajrah*; cf. I.80.12; 52.8; 81.4 etc. *made* i.e., *somasya ābhūṣu* : either the followers of the demon are meant or those of Indra. *dāmani nī ramayan* made him stop in a bond, put him in chains. (4) *tvāṛdhā* : Nominative *tvā* refers to Indra. The simile in *b* is intended in spite of the different genders of the Upamāna and the Upameya. Cf. 51.7 above. See IX.84.2b for the simile. *arhariṣvaṇi* is best derived from *arhari* and *svana*, *arhari* being onomatopoeic : 'one who shouts *arhari*.' (5) Two sentences, with 1 subordinate and 1 chief clause in each half. *vi tiraḥ* is a verb as at VIII.14.7 and X.153.3. *acyutam rajas* is itself the *dharma* of the heaven which Indra has extended below it and above the earth, i.e., midway between the heaven and the earth, so that the former may not fall on the latter; cf. v.6ab and V.85.2. The *ātāḥ* of the heaven are the lower ends of its gates from which the *rajas* is suspended; for the *ātās* of the heaven cf. I.113.14; III.42.6; IX.5.5. *haryā* : Cf. 52.2 above and I.103.2a; VIII.68.14. *d* : Cf. I.85.9d; II.23.18d. (6) *pāyā* (accus. dual from *pāsi*); cf. *paśyoh* IX.102.2. It is probably the same as the *hanū*. Connected with *pā*? Cf. I. 52.6, 15; X.152.3.

(1) I bring my hymn to the mighty, great, most praiseworthy (Indra) who has abundant riches and unfailing strength, whose gift, which is resistless like (the stream) of waters over a slope, is helpful to all creatures and is flung open for the sake of their strength. (2) Everything has yielded to you for guidance; the libations of the sacrificer (have flowed to you) like waters over a slope, when Indra's loving Vajra, which is golden and destroys (the foes), is whetted on the mountain as it were! (3) Bring (an offering) with a prayer at this sacrifice to this fierce and praiseworthy (Indra), oh woman bright like the Dawn! he—whose power, fame and Indra-like lustre were created for being widely heard as his mares were fashioned for travelling. (4) We, who move about closely clinging to you, are yours oh Indra, praised by many and lord of ample riches. For, none else than you can master our hymns, oh lover of the hymns. Gladly accept this speech of ours as the people do (that of their king). (5) Abundant is your power, oh Indra; we are yours. Fulfil the desire of this singer, oh Maghavan. The mighty Dyau has admitted your power, and this earth has bent before your strength. (6) You have battered to pieces that vast and great mountain with your bolt, oh Indra, wielder of the bolt. You set free the imprisoned waters to flow; surely, you hold all power exclusively in yourself.

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(1) *c*: Supply *ūrmih* after *apām* and compare VIII.14.10; 103.11; IX.33.1; 80.5; 108.5 etc. *durdharām rādhas*: Because none can oppose it when Indra wants to give; cf. IV.20.7; 31.9; VIII.14.4 etc. *śavase* i.e., of the worshipper. *apāuṣṭam* so that no efforts are needed to claim it; *rādhas* conceived as a closed treasure. Cf. VII.27.2 (2) *a*: See below v.5cd, *nimnā iva*: *nimnā* is either instrumental singular (cf. IX.17.1; X.78.8; 148.5), or accusative plural (cf. IV.17.2; V.51.7; IX.97.45). *parvate na* is an *Utprekṣā*. A big whetting stone is intended by the word *parvata*. *sam aśīta* (from *sam* √*śi*): Indra is often described as sharpening his Vajra; cf. I.55.1; 130.4; VII.104.19; VIII.15.7; 76.9; X.153.4; 180.2. (3) The verse is evidently addressed to the sacrificer's wife who is brightly dressed for the sacrificial festivity. In *cd*, *na* has again the sense of conjunction as all the things are *Prakṛta*, *śravase* and *ayase* are parallel and all the three, *dhāma nāma* and *jyotis*, are to be construed with the former. *haritah*: Nom. plural of the fem. word *harit*; Indra's horses are sometimes mentioned in the feminine gender. Cf. VI.47.19 (*haritā*); also cf. X.96.9 (*harīṇi*). for *ayase* (infinitive of √*yi*.) cf. IV.21.7d. (4) *saghat* from √*sagh* (secondary form of *sah*) to master, *kṣonir iva*: *kṣonih* is either nomina. or accusa. plural. For the former, cf. *śrutam tat śāsuv iva* I.116.13c; For *kṣonih* cf. I.54.1. With accusa., *d* would mean:—Accept this hymn as you accept your followers. (5) *a*: cf. VIII.92.32c. *kāmam āpr̥ṇa*: See on 16.9 above. *anu ymā* to measure oneself in accordance with i.e., admit superiority of. (with accu. or dative of the superior); cf. I.163.8; VII.21.7 *d*: cf. III.54.15a; V.32.10c.

ATHARVAN IN THE VEDIC AND EPIC LITERATURE

By N. J. SHENDE, M.A., PH.D.

- I) Atharvan in the RV.
- II) Atharvan in the YV.
- III) Atharvan in the AV.
- IV) Atharvan in the Brāhmaṇas and Āraṇyakas.
- V) Atharvan in the Upaniṣads.
- VI) Atharvan in the Avesta.
- VII) Atharvan in the Mahābhārata.
- VIII) Retrospect.

I. *Atharvan in the RV.*

IN the RV, Atharvan in singular stands for the name of the seer and in plural as Atharvāṇaḥ, for the descendants of Atharvan. The word Atharvan occurs fourteen times in the RV. Atharvan figures in the RV, as the seer, who produced Agni by rubbing the pieces of wood, from the lotus flower representing the heaven (RV, 6.16.13). Agni thus born of Atharvan, knows all poetic compositions (RV 10.21.5). After Atharvan, all sages churn Agni like Atharvan (RV 6.15.17). After killing Vala, when the stalls of the cows imprisoned by him were opened by Indra for the Āṅgirasas, Atharvan first laid out the paths by sacrifices for the rising sun to travel. It means that the demon of darkness was killed and the cows representing the rays of the sun were released. Atharvan then first offered sacrifice and cleared the path for the sun to travel. Atharvan, thus is the first sage to perform sacrifice (RV 1.83.5). Gradually the practice of offering sacrifice developed, and the details regarding the offerings and the process of offering came into vogue. Atharvan started the practice of offering the pleasant juice of Soma with milk (RV 9.11.2). Atharvan is identified with Agni, who is called Atharvan. This is just like Agni, called as Āṅgiras. Offerings of Soma are poured in the Ātharvaṇa fire (RV 8.9.7).¹ The Atharvans, along with the Navagvas, the Āṅgirasas and the Bhṛgus are the Fathers, who long to drink Soma (RV 10.14.6). The rites introduced by Atharvans and Manu along with their prayer and praise, meet Indra, as in the olden days (RV 1.80.16). Thus Atharvan in the RV is already an ancient seer, who sings the glory of Indra. Indra admits that he is strong because of the firm support of Atharvan (RV 10.48.2). Naturally Atharvan must have been responsible for making Indra, the great god. The priesthood of Atharvan gradually became a terror to demons and non-believers in Vedic gods; for Agni is invoked to burn up the fool who ruins the truth with falsehood, in the manner of Atharvan (RV 10.87.12). The Atharvans were great priests of fire and in the sacrifices they were paid appropriate fees (dakṣiṇā). The king Aśvattha gave to the Atharvans the chariots with side horses and hundred cows (RV 6.47.24).

¹ The word is *atharvaṇi*. Sāyana takes it to mean 'in the Atharvan fire.' Ludwig takes it in the nominative. I have followed Sāyana.

Dadhyac is the son of Atharvan. He is described to have enkindled Agni (RV 6.16.14). He is also named as Dadhīc at (RV 1.84.13). He and his father Atharvan were the first founders of the institution of sacrifice. Dadhyac knew the secret doctrines of *madhu* and *pravargya* (the secret formula for offering the sweet Soma and the offering of milk in the cauldron). Aśvins knew that Indra had taught these secret doctrines to Dadhyac. They prevailed upon him and after cutting his head, put on his trunk the head of a horse, which taught them those secret doctrines (RV 1.117.22, 116.12). Indra cut off the head of the horse on the trunk of Dadhyac. Indra found the head of the horse at *Saryaṇāvat*.³ With the bones of Dadhīc (or with the bones of the head of the horse, which was joined with the trunk of Dadhīc), Indra killed ninety-nine Vṛtras (RV 1.84.13.14). Brhaddiva is another illustrious member of the family of Atharvan. He is the foremost of the winners of light. (RV 10.120.8). He is called the great Atharvan. He spoke to Indra in person and praised him (RV 10.120.9).

It seems thus that in the RV, Atharvan is the originator of the cult of sacrifice and that he was responsible for popularising Indra, the national god of the Aryans.

II. *Atharvan in the YV.*

The Mādhyandina Saṁhitā of the YV (11.32.33) points out that Atharvan first and then his son Dadhyac enkindled Agni. The same Saṁhitā also mentions that Atharvan is an important priest in the sacrifices (8.56). The Taittirīya Saṁhitā tells that Agni concealed himself from the gods, and Atharvan first saw him and churned him out and enkindled him on the leaf of a lotus. This Saṁhitā thus explains the reason of churning out Agni. Agni had disappeared from the gods. But Atharvan brought him back and employed him in the sacrificial functions. This perhaps suggests that the cult of fire was sometime lost and later on revived by Atharvan (TS. 3.5.11.4; 4.1.3.3, 5.1.4). The Maitrāyaṇī Saṁhitā (3.1.5) and Kāthaka Saṁhita (19.4) elevate Atharvan to the status of the Prajāpati.

It may be observed here that Atharvan in the RV and YV does not figure so prominently as Aṅgiras. Even Angiras himself individually does not much contribute to the composition of the Vedic hymns, as his descendants do. It may be that his activities were centred round composition of the hymns of the Atharva Veda, and propagating the Atharvaṇic religion.

III. *Atharvan in the AV.*

The word Atharvan occurs 23 times, and once as Atharvāṅgiras in the AV. Sixteen times it occurs in singular. The word Ātharvaṇa occurs six times in the AV and therein only once in singular.

Atharvan figures in the AV as a god, as a Father and as a seer. He is mentioned as Divine Atharvan along with Aṅgiras as residing in Kāla or the Eternal Time (AV 19.54.5). He is the kinsman of the gods, and the father of the Ātharvaṇas (AV 7.2.1).

³ A lake or a district in Kuruksetra. See Vedic index, Vol. II, p. 364. At this place, Indra found out the head of the horse, on the trunk of Aśvins. The head of the horse seems to have fallen at this place, after it was cut by Indra.

He is one of the Pitrs or the Fathers and is mentioned along with the Āṅgirasas, the Bhṛgu and the Navagvas (AV 13.1.58).

As a seer and priest of fire, Atharvan is the first sacrificer. He offered the first offering to Agni (AV 19.4.1). He filled a ladle with oblation to be offered to Indra (AV 18.3.54). The Atharvans sing loudly the prayer for Savitr in the evening (AV 6.1.1). Varuṇa gave a dappled cow to Atharvan (AV 7.109.1). There is a dialogue between Atharvan and Varuṇa, who wants to take back the gift, which he himself bestowed on Atharvan (AV 5.11.2-11). Thus Atharvan himself being of the status of a god, had a very close association with the gods, such as Indra, Varuṇa and Savitr.

After an appeal made by Atharvan, Varuṇa agreed to keep the cow with Atharvan. Varuṇa then praised Atharvan as the god, who gives life to the gods and who praises him, and as a sage strengthens the sages, who sings his glory (AV 5.11.10). The poet then says that Varuṇa has begotten Atharvan, the kinsman of the gods, the sire (AV 5.11.11).

The present version of the AV, consisting of twenty books, in the Śaunaka Śākhā, gets the name of the eponymous seer Atharvan. The different books of the Veda are paid homage to, at AV 19.23. The hymns, composed by the Āṅgirasas are also paid homage to, at AV 19.22. The Atharvāṅgiras is the name of the AV, forming the mouth of Skambha. The Āṅgirasas saw the Veda and reproduced it from his mouth; thus the Veda gets the name, Atharvāṅgirasa. This speaks of the unity of the families of Atharvan and Āṅgiras, the two fire-priests of the ancient past, and who are regarded as the Fathers by their succeeding generations. Their Veda, the AV was existing along with the other vedas; but was taken to be 'unreal'. However people know it to be 'the great Veda.' Inferior people considered that the Veda was real and worshipped it (AV 10.7.21).

Atharvan is credited with the act of perfecting the structure of man, fashioned by Brahman. Atharvan sewed together his head and heart and sent forth the purifying wind from the brain out of his head. Thus the human head is fashioned by Atharvan (AV 10.2.26-27). Atharvan is thus Prajāpati.

Atharvan is known for the use of herbs in treating diseases. They are known as the plants of Atharvan like those of the Āṅgirasas (AV 11.4.11). Thus Atharvan and Angiras were the medicine-men of those times, sponsoring the use of plants for curing diseases. The plant *ajāśṛṅgi* is used by Atharvan for killing the demons (AV 4.37.1). Atharvan and Ātharvaṇas tied on themselves the amulet of *khadira*. With their association, the Āṅgirasas broke open the fortress of the *dāryas* (AV 10.6.20). The Āṅgirasas are described as the partners or colleagues of the Ātharvaṇas (*ibid*).

Atharvan is the seer of more than 200 hymns in the AV. Atharvan seems to belong to the family of Āṅgiras, as the name Ātharvāṅgiras in singular, indicates. Thus together, the Āṅgirasas and Atharvan are responsible for 220 hymns in the AV. The Atharvans are paid homage to in the AV itself as the seers of the different books of the (AV.19.23).

IV. *Atharvan in the Brāhmaṇas and Āraṇyakas*

In the Brāhmaṇa literature we find reference to the birth of Agni from Atharvan (Sāṅkhāyana Brāhmaṇa 22.6). The Taittirīya Brāhmaṇa deifies Atharvan and invokes him to protect the sacrificial food (TB. 1.1.10.2).⁸ The Brāhmaṇa considers also by the term Atharvan, the compositions of the Atharvan, as distinguished from those of the Āṅgīrasas but forming together one Veda. For instance, the four Vedas have been assigned to the different directions. The Veda of the Āṅgīrasas and the Atharvan is assigned one direction, *viz.*, the west. Thus the Brāhmaṇa considers it to be one Veda (TB 3.12.9.1). The different Vedas serve as different *mantras* for laying down the bricks in the Agnicayana sacrifice. Among the Vedas are mentioned the Atharvāṅgīrasas to represent the AV (TB 3.12.8.1-2).

The Śatapatha Brāhmaṇa refers to the story of teaching of the *madhu* and *pravargya vidyā* by Dadhyac, the son of Atharvan, who knew the pure essence of sacrifice, to Aśvins to make the sacrifice complete (SB. 14.1.1.18.25; 4.1.5.18). The SB recognises the Atharvan Veda as the fourth Veda. It is called the Veda of the Atharvāṅgīrasas (SB. 14.5.4.10). The SB also refers to the two distinct parts of the AV, as the veda of Atharvan and of the Āṅgīrasas. It also points out that Atharvan is the Veda of the Gandharvas and Āṅgīras in the veda of the Apsarasas. This occurs in the context of the recitation of the Atharvan and Āṅgīras texts on the third day from the release of the horse at the Aśvamedha sacrifice (SB.13.4.3.7-8). The SB makes the use of the magical character of the AV in the sacrificial details. In the Soma sacrifice, if the Soma were to meet any mishap while it is being taken down from the car, the sacrificer should offer an oblation to Atharvan; for, the SB informs us that the sacrificer is Atharvan. He repels evil and the sacrifice inclines towards him (SB.12.6.1.18). The Tāṇḍyamahābrāhmaṇa attributes many Sāmans to Atharvan. A person desirous of securing the heavenly worlds should recite the *brahmasāman* of the Atharvans; for, the Atharvans desirous of securing the heavenly world saw the Sāman, and consequently reached the immortal world, the Svarga (TMB 8.2.5-6). Another Sāman, which Atharvan saw is *caturṇidhāna sāman*. The TMB explains that the Atharvaṇas deal with medicine. This Sāman does the work of medicine (TMB.12.9.8-10). Another Sāman called *ātharvaṇa* is in the *anuṣṭup* metre. This Sāman guarantees the singers complete security in all affairs; for, the *ātharvaṇa* is the medicine of the gods (TMB.16.10.9).

It will be observed that though Atharvan is claimed to be the first seer to start the institution of sacrifice and kindling Agni, still in the RV in the YV and in the Brāhmaṇas, not much is said about him. This deficiency is filled up by the treatment he meets in the AV and the Gopatha Brāhmaṇa. The GB glorifies Atharvan and elevates him to the status of Prajāpati. Brahman was alone in the beginning. It thought of creation. Having created Bhṛgu, it generated Atharvan from the waters. Atharvan, thus born of Brahman, had on his body

⁸ Sāyaṇa considers that the southern Agni represents Atharvan, the propounder of the fourth Veda.

hair, limbs and active soul, like Brahman. Brahman then asked Atharvan to protect the creatures. Hence he became Prajāpati. Brahman then caused Atharvan to practise penance. From him ten Ātharvaṇa sages were born. These ten sages in turn again produced ten descendants of Atharvan. These twenty Ātharvaṇas are the seers of the twenty books of the AV. The Veda thus produced is the best of the Vedas and is born of penance (GB.1.1.5,6,9). Five supplementary Vedas such as *sarpaveda*, *piśācaveda*, *itihāsaveda*, *asuraveda* and *purāṇaveda*, were produced from penance. These are the supplementary Vedas of the AV (GB 1.1.110).

The GB describes at great length the position of the AV and the Brahman priest in the sacrificial system of the Brāhmaṇas. It is of the opinion that the Brahman knowing the AV is absolutely essential for the completion and success of the sacrifice. The Brahman knowing the AV is called *atharvāṅgiroid* or *bhṛgvāṅgiroid* (GB.1.31-2). The GB (1.1.14) tells that the sacrificers who have deficiently performed the sacrifice, should run to the Brahman and should request him to make good the deficiency by performing the *Śāntiyudaka* (pacifactory rite with water). This Brahman is the same as Atharvan (the priest), who performs the expiatory rites to remove the defects in the performance of sacrifice. On doing these rites, the sacrificer escapes from premature death and moves freely in the worlds. Atharvaṇic priest at the time of the sacrifice sits to the south facing east and offers oblations of ghee in the fire (GB.1.1.15). All these Vedas follow the AV (GB. 1.1.39). Atharvan first started the rite of *brahmaudana* at the time of the deposition of Agni (GB. 12.15.16). Vicārin, the son of Kabandha Ātharvaṇa pacified Agni by means of the recitations of the hymns attributed to Atharvan and Āṅgiras (GB.1.2.18). The Veda of the Atharvans constitutes half of the sacred knowledge and all three vedas constitute the other half. The Veda of the Bhṛgvāṅgirasas (*i.e.* the AV) is composed by the Āṅgirasas and the Atharvans. The Veda of the Artharvans deal with medicine, which is the immortal Brahman (GB.1.3.4).⁴ The Atharvāṅgirasas thus claimed themselves to be very important and influential priests in the sacrificial systems. The GB, while giving the explanation of the word *dīkṣā* (consecration), points out, that a person, who is consecrated is not expected to rise up, when some one comes or to salute him on his arrival. For the Atharvāṅgirasas, who alone deserve the honour of being saluted, have entered in him. The Atharvans are those, who offer sacrifices in themselves (they being like Agni). The Āṅgirasas do not mention their own names, nor of others. They speak select words (GB.1.3.19). The GB thus summarises that the importance of the Atharvāṅgirasas is so great that without their protection the sacrifice limps like an animal deprived of its feet. But with it, it goes to the heaven being fully equipped with all its parts (GB 1.4.28). The followers of Atharvan are higher than those of the other three Vedas. The followers of the three Vedas after their death reach the heaven, but those of the AV, reach the region further than the heaven, called the world of the Brahman, which is the final resort of the Atharvāṅgirasas (GB.1.4.25).

•⁴ Cf. एतद्वै भूयिष्ठं ब्रह्म यद्भृग्वंगिरसो ये ऽ जिरसः स रसो ये ऽ यर्वाणः तद्भेषजं, यद्भेषजं तदमृतं यदमृतं तद्ब्रह्म । GB 1.3.4.

It will thus be seen that the GB gives common origin to Atharvan, Bṛghu and Āṅgiras. Their Veda is called after them. The place of the Atharvans or Atharvāṅgirasas in the sacrificial system is claimed to be very high and indispensable. The knowledge that they impart is half of that which is given by the other three Vedas. Thus the AV is equal to all the three Vedas. All sacrifices reach the Āṅgirasas. The followers of the AV attain the world of the Brahman, which is superior to, and over and above the heaven, which is reached by the followers of the three Vedas. The main task of the AV in the sacrifice is to rectify the errors in the performance of the sacrifices and offer expiatory rites. The main function of the Atharvaṇic hymns, as distinguished from the Āṅgirasa hymns is to offer medical treatment to the suffering patients. However this does not appear to be their exclusive field. There is no such clear-cut distinction between the hymns of Atharvan and Āṅgiras. The claim that the Āṅgirasas are horrible and deal with deadly magic and that the Atharvans deal with sympathetic magic is not based on any principle.

The Taittiriya Āraṇyaka, while describing the metaphorical sacrifice of Brahman, points out that the study of the Atharvāṅgiras (the AV) is the same as offering honey in the sacrifice. (TA2-9). The Sāṅkhāyana Āraṇyaka, having given the views of Māṇḍavya, Māṇḍukeya and Yājñavalkya, tells that the Ātman should be searched after in accordance with the teaching of the Veda. This secret doctrine is the head of the Vedas. This doctrine is nothing but the clean shaven head of the AV (SA.13.1,14.1). It thus seems that the followers of the AV, were distinguished from those of the other Vedas, by their clean shaven heads.

V. Atharvan in the Upaniṣads

In the Upaniṣadic period we find a considerable activity of the Atharvans.⁵ Dr. Farquhar gives a list of 112 Upaniṣads belonging to the Atharvans.⁶ However, we can say that there are 68 Atharvaṇic Upaniṣads.⁷ The Atharvaṇic tradition has to its credit the Muṇḍaka, Praśna and Māṇḍūkeya. In the Upaniṣads of the other Vedas too, the Atharvans play a very important part. The Taittiriya Upaniṣad (2.3) mentions that the Atharvāṅgirasas form the very basis of the knowledge of the Ātman. The Chāndogya Upaniṣad (3-4) describes that the Brahman is a beehive. The hymns of the AV are the bees in the beehive. The Bṛhadāraṇyaka Upaniṣad (2.5) introduces the famous *madhu vidyā* of Dadhyac Atharvan. We have seen that, this *vidyā* along with the *pravargya vidyā* are taught to Dadhyac, the son of Atharvan, by Indra himself. It was then told to Aśvins. The Upaniṣad describes the *vidyā* philosophically while the SB describes it ritually. The *madhu vidyā* of Dadhyac is the doctrine of the mutual interdependence of the things in the universe, because all of them are indissolubly connected in and through the self. Thus Dadhyac preaches here the doctrine of the supreme existence of the one and the apparent existence of the many. At another place Kabandha Ātharvaṇa teaches the doctrines

⁵ See my articles in *Prācyavāṇī*, Calcutta, 'The Atharvaṇic Upaniṣads,' July 1944, April 1945.

⁶ Cf. Outline of Religious Literature of India, p. 364.

⁷ Cf. Atharvaṇic Upaniṣads by N. J. Shende, *ibid*, p. 88.

of *sūtra* and *antaryāmin*. Air is the *sūtra* or the thread which weaves together the different worlds and the beings that live in them, and Ātman is the *antaryāmin*, the inner controller of all things in the Universe (Cha. UP.3.7). In the Atharvaṇic Upaniṣads proper, we get an idea of the literary and philosophical activities of the Atharvans. Praśna Upaniṣad 2.8, points out that Atharvan is the pre-eminent member in the family of Angiras. The Cūlikā Upaniṣad (10) further tells that the Atharvans are the best of the Bṛhgu. It is thus clear that the families of Angiras, Atharvan and Bṛhgu are related to each other. The AV was preserved in 9 *śākhās* out of which only two are extant viz. the *śaunaka* and the *paippalāda*. There is one Upaniṣad named Tripād vibhūtimahānārāyaṇa of the *devadarśi śākhā* of the AV. The Sītā Upaniṣad points out that Atharvāṅgiras Veda is the essence of the Vedas. The Sūrya Upaniṣad is the praise of Sūrya by Atharvāṅgiras. In the Śāṇḍilya Upaniṣad Śāṇḍilya is instructed into the eightfold *yoga* as a means of securing salvation by Atharvan, who figures here as a teacher of *yoga*. On receiving instructions from Atharvan, Śāṇḍilya seems to have founded the Pāñcarātra system.⁸ The Atharvaśiras, the Yogaśikhā, the Devī, the Gaṇapati and the Mahāvākya Upaniṣads are called the Atharvaśiras, the sacred knowledge of the Atharvans.

In these various Atharvaṇic Upaniṣads, the Ātharvaṇa teachers teach the *Bhāgavata Dharma* in its various stages such as the worship of Vāsudeva, Kṛṣṇa, Nārāyaṇa, Viṣṇu and Gopāla. They also preach the worship of Śiva and Durgā in various aspects. In addition to this they glorified the other deities such as Gaṇapati, Sūrya and Dattātreyā. Thus, they first evolved the worship of the Hindu Trinity viz. Brahmā, Viṣṇu and Śiva and they might be said to have influenced the worship of the *pañcāyatana*, consisting of five deities, such as, Nārāyaṇa, Gaṇeśa, Saṅkara, Sūrya and Devī. This might be an attempt at the fusion of the Śiva and Bhāgavata forms of worship, which gave rise to the *smārta dharma*.⁹

We can thus observe that the Atharvaṇic teachers were prominent in the Upaniṣads (old and new). It is possible that they among other Brāhmaṇas, took the lead in the philosophical matters in the Upaniṣadic period, connected as they were with the Kṣatriyas who raised a banner of revolt against the prevalent sacrificial religion of the Brāhmaṇas.

VI. Atharvan in the Avesta

Atharvan can be traced to Indo-Iranian period. In the Avesta, the Athravans (corresponding to the Sanskrit Atharvan) are the Zoroastrian priests of Eastern Iran. Athravan is the generic name for the priests in the Avestan texts. Zarathushtra is called Athravan. Nature hails him at his birth as an Athravan.¹⁰ He is the very first and foremost of the Athravans.¹¹ Ahura Mazda himself takes this term to define one of his many names.¹² The class designation of the priests in the Avestan

⁸ Ibid.

⁹ Ibid.

¹⁰ Yasht 13.94.

¹¹ Yasht 13.88, 89.

¹² Yasht 1.12.

texts is persistently Athravan.¹³ Like the Vedic people the Avestan people divided their society into different professional groups and the Athravans formed the first of them. They were priests of fire and it was their special duty to tend the sacred flames in the shrines and also to go abroad preaching the religion of Mazda.¹⁴ But this specialisation of the priesthood by the Athravans is in the later Avesta. Zarathushtra does not recognise the fourfold order of the society in the Gāthās. The Pahlavi texts use this designation for the priestly class, but also in addition call the Athravan as magopat or magpat, corresponding to the Greek form Magi or Magus. Zarathushtra uses the form derived from maga, 'great'.¹⁵ Atar is the word in the Avesta for fire and Athravans are those, who tend fire. Moulton points out that the Athravans do not appear in the Gāthās, and there is a hint in the Haptanghaiti Gāthā, that they came from abroad.¹⁶

In the Avesta we find that the priest, who tends fire is Athravan and in the later Avesta the word stands for the community of the priests, like the Brāhmaṇas in the Vedas. They were the foremost people in the society. The Athravans were influenced by the Magis. The Magi formed one of the six tribes into which Medes were divided and constituted their priestly class. They wore white robes and covered their head with woollen cloth. The disposal of the dead by the exposure to the light of the sun, the reverence for the elements of fire, water, and earth and the stringent laws for bodily cleanliness, the active crusade against noxious creation are some of the salient features of the religious practices and beliefs of the Magi, that can be gathered from the writings of the Greek authors. All these form the cardinal tenets of the Vendidad and all are associated with the Athravans, who make up the official priesthood of the Avestan people.¹⁷ It is possible that these Magis might have inherited from their ancestors the sorcery or the magical practices. It will thus be seen that in the Avesta, the Athravans are known to be the priests of fire and are directly connected with the Atharvans, the seers of the AV. This indicates that in the Indo-Iranian period, the Atharvans formed the priestly community, inheriting the magical practices among the Vedic Aryans. The Atharvans at this time might have been influenced by the Magis, the members of another ancient priestly class, practising magic. Of all Brahmanical families in the RV, the Atharvans and the Kavis seem to be more closely connected with the Avesta. These two families of the priests belong to the main family of Bhr̥gvaṅgiras. The other priestly families in the Vedas seem to have been included in the name Athravan in the Avesta. When the Aryans came to India the religion of the Atharvans found scope among the Aryan community in the villages, which called on the Atharvanic priest to effect or remove the effect of magic and treat the sick with his medical knowledge. Some members of the class

¹³ Cf. Dhalla, *History of Zoroastrianism*, p. 136.

¹⁴ Ibid. 129-130 and Yasht 42.6.

¹⁵ Ibid, p. 73. Also see Moulton, *Magi* in ERE, Vol. VIII, pp. 242-44.

¹⁶ Cf. *Early Zoroastrianism*, pp. 88, 116, and Yasna 42.6.

¹⁷ Cf. Dhalla, *op. cit.*, p. 136. Also compare Jackson, *Zoroaster*, pp. 138, 141. The Magis also possessed the knowledge of onciromancy (divining of dreams, and astrology). See Moulton *loc. cit.* The word magic refers to the religion, learning and practices of the Magis the priests of the sect of Zoroaster; see Maret ERE. Vol. VII, p. 245.

sought the jobs of the *purohita* an officiating priest at the royal court. In the meanwhile, the Vedic Aryans developed a fullfledged system of the sacrifice, requiring the use of the RV, YV and SV. The Priesthood of the Atharvans was generally neglected as it failed to attract the attention of the followers of the three Vedas, who were engrossed in the pompous performance of the sacrifices. But the religion of sacrifice in its glorious days gradually included the magical practices of the Atharvans in its ritual. So the priestly office of the Brahman was evolved, as it was necessary for the priest to know the expiatory rites, and the correction of the wrong ritualistic practices. The Atharvavedins claimed that the Brahman must be a *Bṛgvaṅgirovid* (knowing the AV). Thus the followers of the three Vedas, realising the importance the Atharvanic practices, incorporated the office of Brahman in their own system and recognised the AV as the fourth Veda.¹⁸ Primarily the AV does not pretend to help the sacrifices sponsored by the followers of the three vedas. All attempts such as those of Sāyaṇa and the Sūtras, to employ the hymns of the AV for the sacrificial purposes are farfetched and are quite later. In fact the AV, aims at the simplification of the types of the sacrifices such as *savas* which were equally effective and less expensive. They also preached the symbolical sacrifices, like the hospitality shown to a guest. The Atharvanic priests were reformists in their tendencies, since they admitted and deified the *Vrātyas*, who were outside the pale of the orthodox Aryans. The domestic rites gradually assumed the place of popular religion, when the religion of sacrifice lost its sway over the public. The AV specially deals with the domestic rites. The AV has alone an entire book devoted to the marriage rites.¹⁹

The Atharvans must have been included in the orthodox Brahmanism at the time of the composition of the white Yajurveda. For the black YV seems to be antagonistic to the AV. This fusion must have taken place after the split of the YV into the black and white.

Thus we may say that before the Aryans came to India, the Vedic society had a special class of the priests called Atharvans, but when they settled down in India, in the gradual expansion of the religion of the *yajña*, they lost their original position, and their place was taken by the *Hotṛs*, *Udgātṛs* and *Adhvaryus*.²⁰ They regained their position at the time of the *Brāhmaṇas*, when their magical religion was admitted into the orthodox Brahmanism. However they maintained their individuality, though there did not remain much difference between the orthodox Brahmanism and the Atharvanic religion.

The Jain texts refer to the AV many times.²¹ Generally they refer to the *purohita*, as expert in the practice of the AV and having the knowledge of the three Vedas also. He helps the king in all his private and public matters. The Buddhist writings refer to the AV along with the other Vedas. The *Tevijjasutta* condemns the Atharvanic practices.²²

¹⁸ Cf. *Jñānakośa* by Dr. S. V. Ketkar, Vol. II, p. 205.208.

¹⁹ Cf. *Jñānakośa*, supra, p. 216.

²⁰ Cf. *Jñānakośa*, supra, p. 226.

²¹ Cf. *Vivāgasutta*, 106, *Nāyādhammakahā* 5, 16; *Bhagavai* 6, 33.

²² Bloomfield, *Hymns of the AV*, SBE, Vol. XLII, p. ilvi.

VII. *Atharvan in the Mahābhārata*²³

The word Atharvan or Atharvāṅgiras is used in the Mbh as the name of the seer Atharvan and as the designation of the Atharva Veda. An attempt is made here to consider the achievements of Atharvan in both of these capacities.

The Mbh is closely connected with the AV. The Mbh is an *itihāsa* (legendary account) of the Bharatas. In the *nimiṣa* forest, at the sacrificial session, lasting for twelve years, performed by the sage Śaunaka, Sūta or Sauti, by name Ugraśravas, the recitor of the *purāṇas* by profession, came and the sages attending the sacrificial session requested him to narrate to them the *samhitā* of the *itihāsa* of the Bharatas, which is the present Mbh, the collection of the legends of the Bharatas. This *itihāsa* was narrated by the *kavis* of the past (1.1.1-19,²⁴). The *itihāsa* is considered by the Gopatha Brāhmaṇa (1.10) as the supplementary Veda of the AV. In fact the Mbh itself is called a Veda (1.1.205). Thus the study of the legends and myths was specially preserved in the *śākhās* of the AV. It is possible that the Atharvaṇic priests claiming themselves to be the *purohitas* for the officiating priests of the royal families, might have been the repositories of the legends pertaining to the Brāhmaṇas and the Kṣatriyas or the ruling families. Their influence as the royal *purohitas* on the kings was tremendous. Hence they may be intimately connected with the royal and the Brahmanical legends preserved in the Mbh.

The seer Atharvan is credited with chanting of the Vedas for the first time. He is thus not only the seer of the AV, but of all Vedas (5.43.30). In the Brāhmaṇa literature, as we have seen, the AV is recognised as the fourth Veda. The SB refers to it often. It is thus maintained that though the hymns of AV were current among the Vedic Aryans, the collection of those hymns, received the name Atharvāṅgiras, only at the time of the Brāhmaṇas. Till then the AV was not recognised as the fourth Veda, nor was the Atharvaṇic priest allowed to participate in the sacrifices. The Mbh tells the story of the recognition of the AV and the participation of the Atharvaṇic priest in the sacrifices. Indra killed Triśiras, a son of Tvṣṭr. Being enraged at the murder of his son, Tvṣṭr offered oblations in Agni and produced a formidable son by name Vṛtra (5.9.43). Indra killed Vṛtra with fraud. He discharged his thunderbolt, concealed in foam and killed Vṛtra (5.10.38). Indra thus killed Triśiras and Vṛtra, the Brāhmaṇas. As a result of the sin of killing the Brāhmaṇas, he lost his consciousness and remained concealed in water (5.10.42,43). The whole world became depressed at his disappearance from the world. Nahuṣa was crowned as Indra after him. As Indra, Nahuṣa desired that Indrāṇi should treat him as her lord (5.11.14). She came to Brhaspati-Āṅgiras, who gave protection to her and promised to bring back Indra (5.11.21). At the instance of Viṣṇu, a horse sacrifice was offered to expiate Indra of the sin of killing a Brāhmaṇa. Yet Nahuṣa could not be dethroned.

²³ The references with the asterisk mark refer to the Bombay edition of the Mbh. and those without it refer to the critical edn. of the Mbh. published by the B.O.R.I., Poona.

²⁴ The word Kavi means an intelligent person. It may also refer to the priests of the Iranian kings, who got a designation after them; cf. Haug: Essays on the sacred Language and religion of the Parsees, pp. 235-236.

Through the help of a deity called Upaśruti, Indrāṇī found out Indra in the stem of a lotus in a lake far north of the Himālaya mountain (5.14.9). Indra asked her to go to Nahuṣa in a chariot yoked by the sages (5.15.4). Br̥haspati offered sacrifice to destroy Nahuṣa (5.15.25). Agni, pacified by this sacrifice, found out Indra. Br̥haspati went to him and praised him. At the same time Agastya cursed Nahuṣa to be a serpent (5.17.15). Indra, thus found out, was praised by gods, Gandharvas and Apsarases. Then the godly Aṅgiras presented himself before him and worshipped him with the hymns from the Atharva-veda. Indra was pleased and granted a boon to Atharvāṅgiras that his Veda would be known after that time as the Atharvāṅgiras Veda, and that he would get a portion of the offerings in the sacrifice. Indra then worshipped Atharvāṅgiras and allowed him to go (5.18.5-8).

In this story, thus, we are told the following important facts, leading to the recognition of the AV.²⁵ 1) The Atharva Veda is designated as the Atharvāṅgiras Veda, and a portion in the sacrifice is assigned to the Atharvaṇic priests. Indra sets this example to be followed by others. 2) The charms of the AV are recited by Aṅgiras, who is the same as Atharvāṅgiras or Atharvan, mentioned later on in the same context. It shows that divine Aṅgiras is the family name of Atharvan, who is called twice in this passage as Atharvāṅgiras (in singular), representing the seer Atharvan in the family of Aṅgiras. The AV calls the Aṅgirasas as the *medins*, the companions or colleagues of the Atharvans (AV. 10.6.20). Thus the difference made by the SB as the Aṅgirasa Veda and Atharvaṇa Veda merely refers to the compositions of different members of one family. It does not mean any essential difference in the nature of the two types of the compositions, viz. the Aṅgirasas standing for the hostile charms and Atharvan standing for peaceful or beneficent charms.²⁶ Thus Atharvāṅgiras is styled as the divine Aṅgiras who appeared before Indra to praise him with the charms from the AV. Br̥haspati, the best of the Aṅgirasas also plays an important part in the search of Indra. 3) Looking through this narration, we may say that the AV and the seer Atharvāṅgiras played an important part in the reinstatement of Indra, who had lost his spiritual grandeur on account of the killing of Vṛtra. Thus the credit of reviving the cult of sacrifice and restoring the glory of Indra goes to the AV and Atharvan. It may be maintained that this event refers to the compromise effected between the followers of the three Vedas and the Atharvavedins, by allowing the position of the Brahman the all-knowing priest, proficient in the knowledge of the AV in the scheme of the sacrifice and by recognising the AV as the Veda. This might have happened in the Brāh-

²⁵ Cf. ततः स भगवांस्तत्र अङ्गिराः समदृश्यत ।

अथर्ववेदमन्त्रैश्च देवेन्द्रं समपूजयत् ॥

ततस्तु भगवानिन्द्रः प्रहृष्टः समपश्यत ।

वरं च प्रददौ तस्मै अथर्वाङ्गिरसे तदा ॥

अथर्वाङ्गिरसं नाम अस्मिन्वेदे भाविष्यति ।

उदाहरणमेतन्नि यज्ञभागं च लप्स्यसे ॥

एवं संपूज्य भगवानथर्वाङ्गिरसे तदा ।

व्यसजयत् महाराज देवराजः शतक्रतुः ॥ Mbh. 5.18.5-8.

²⁶ Cf. Whitney, Atharva Veda : Translation, p. 1039.

maṇa period, since the Brāhmaṇas and particularly the SB refers to the AV. The Atharvavedins claim that the revival of the sacrifice and the reinstatement of Indra are due to them. The Mbh prominently contains the glories of the AV and its seer. The Mbh thus records that the AV got its dignified position as the Veda and due share in the ritual of the sacrifice, which were denied to it due to the popular nature of its teaching. The prominence of the Atharvaṇic ideology and of the AV in the Mbh is noticed in the following manner.

The influence of the AV is felt in the various narrations of the Mbh.

(i) The rites for giving birth to a male child (*puṁsavana*) and for conception : The AV (5.25; 6.11) describes the rites mentioned above. For securing the birth of a male child, various deities are invoked to deposit the seed. The woman is given a drink called *garbhakarāṇa* (securing impregnation), which is known by Varuṇa, Indra and Sarasvatī (AV 5.25.6). In the Atharvaṇic charm for securing the birth of a male child, there is the recitation of the charms (*mantras*), drinking of some drink, eating of cooked rice (*caru*) or any charmed object (Kauśika 4.11). In the Mbh this charm is found to have been used in a number of places. The birth of Karna and of the five Pāṇḍavas is attributed to the charms from the AV. The story of their birth is told in a number of places. Firstly, it is told in the Ādiparvan and its improved version is found in the Āraṇyakaparvan. The rite of *puṁsavana* is referred to by Pāṇḍu in the Ādiparvan. He is urged by the ascetics, staying in the region of the Gandhamādana mountain to procreate son, who would ensure his entrance in the heaven. Pāṇḍu was wandering with his two wives in that region. He tells his wife, Kuntī, the story of Śaradāṇḍāyaṇī, who becoming herself pure, offered offerings in the fire, lighted for the purpose of *puṁsavana* i.e., the birth of a male child (1. 111. 34). Kuntī in response to the request made by Pāṇḍu tells him that she had received some charms (*mantragrāma*) from the sage Durvāsas, who was born in the family of Bhṛgu (1. 113. 15). The charm was given to her during her virgin days (1. 104. 6).²⁷ In the Kuṇḍalaharaṇaparvan of the Āraṇyakaparvan, it is told that a certain Brāhmaṇa having bright lustre on his body, bearing beard, matted hair and staff came to her father Kuntibhoja. He stayed as a guest in his house and was treated to his satisfaction by his daughter, Kuntī (3. 288. 1. 19). At the end of the year, being pleased with her services, Durvāsas granted her a boon by means of which any god, whomsoever she called would be at her disposal (3. 289. 16, 17). He then gave her the charm, as taught in the AV (3. 289. 20).²⁸ Kuntī had some great curiosity regarding the use of the *mantras* given by Durvāsas. One day she sipped water and recited the charm and invoked the sun, who appeared before her in human form. She gave birth to Karna, who secured from the sun the armour and the earrings (3. 291. 17). This was the first use of the *mantras* from the AV. On the Gandhamādana mountain, Kuntī, desirous of getting sons offered offerings in fire and with due rite,

²⁷ Cf. तस्यै स प्रददौ मन्त्रमापद्धर्मान्वेक्षया ।
अभिचाराभिसंयुक्तमब्रवीच्चैव तां मुनिः ॥

²⁸ Cf. ततस्तामनवद्याङ्गिं प्राहयामास वै द्विजः ।
मन्त्रप्राप्तं तदा राजन्नथर्वशिरसि श्रुतम् ॥

muttered the charms, given by Durvāsas (1. 114. 1-3). Thus Yudhiṣṭhira, Bhīma and Arjuna were born of her.²⁹ Kuntī favoured Mādrī by allowing her the use of the Atharvaṇic charm given to her by Durvāsas. Mādrī gave birth to Nakula and Sahadeva (1. 115. 17). It is thus due to the charms or *mantras* from the AV, that the five Pāṇḍava^s and Karṇa were born.

The magical rite for the birth of a son is referred to in the birth of Aruṇa and Garutmat from Vinatā. She observed a vow and becoming pure practised the rite of *puṁsavana* (1. 27. 24). Also Bharata, the son of Śakuntalā and Duṣyanta secured a son due to the favour of the sage, Bharadvāja Āṅgīrasa (1. 89. 18). The birth of Viśvāmitra and Jamadagni is also due to the eating of *caru* or cooked rice, charmed with the magical powers. King Gādhi gave his daughter Satyavatī to Ṛcika, a Bhārgava. Ṛcika gave to his wife and mother-in-law the two *carus*, purified with the recitation of the charms, obviously from the AV. These two women exchanged the *carus*. As a result of this a Brāhmaṇa Jamadagni was born with the martial qualities and a Kṣatriya Viśvāmitra was born with the Brahmanic qualities (13. 4. 39).^{*} The story of the birth of Vainya is another instance of the power of the charms of the AV. Vena who was killed by the Brāhmaṇas knowing *brahman*, had his right hand rubbed by the sages and Vainya was produced from it. His officiating priest was Śukra, who was a store of the *brahman* (12. 59. 93; 111).^{*} At another place, while narrating the birth of Māndhātṛ, it is told that Bhṛgu officiated at a sacrifice offered by king Sudyumna to secure a son for him. Bhṛgu charmed water and kept it at night in a jar, which was kept in the sacrificial chamber. It was intended to be drunk by the queen of Sudyumna. But King Yuvanāśva coming there at night from the hunting expedition, drunk it without knowing its consequences. As a result of this, he conceived and Māndhātṛ was born of him. It may be noted that Bhṛgu employed the *brahman* (the mysterious magical power), which he secured by practising severe penance, in the preparation of the charmed water. This charmed water was intended to be drunk by the queen, who desired to have a son. It seems to be the same drink, called *garbhakaraṇa* referred to at AV. 5. 25. 6. (3. 126. 19—23). The birth of Dhṛṣṭadyumna is also due to the offering in the Atharvaṇic fire by the priests, Yāja and Upayāja (1. 155. 32. 36). In the account about the birth of Jarāsandha, the son of the king Brhadratha the lord of the Magadhas, it is told that Caṇḍakauśika, belonging to the family of Gautama Āṅgīrasa charmed a mango fruit and gave it the two wives of the king. The charm was intended to secure the birth of a son (2. 16. 29). It is interesting to note that all sages mentioned in the stories referred to above are the members of the family of Bhṛgvaṅgīras, such as Durvāsas, Bharadvāja, Ṛcika, Śukra Bhṛgu and Gautama. It cannot be a mere accident that these names were associated with the magical rite to secure a son. Moreover the AV 5. 25 refers to such a rite and drink or eating of cooked rice or any charmed object to secure the birth of a son.

(ii) Draupadī refers to the practices of women to win their husbands. Satyabhāmā asks Draupadī the secret of her successful life as the wife

²⁹ In the version of the story in the Ādi, the name of the Brāhmaṇa who gave that charm is mentioned to be the Durvāsas. In the version in the Āraṇkyā, he is only mentioned to be a Brāhmaṇa.

of the Pāṇḍavas. She asks her whether she used any charm, roots and herbs, ointment or any medicine to win the husband. Such rites are described in the AV and called *stri-karmāṇi*, which form the basis of the systematic treatises such as the Kāmasūtra of Vātsyāna (3.222.6.8 and also AV., 9.23.25, 3.30, 6.78, 2.36, 6.60, 6.11, 4.4).

(iii) The spirits attacking a pregnant woman: Agni fell in love with Sīvā the wife of Aṅgiras. Skanda was born of them. From his body many spirits and *piśācas* were produced. They devour the embryos of the pregnant women and cause defect in their embryos. Their evil effect is removed by offering rice and by the worship of Skanda, a form of Agni. The AV. 8.6 speaks of the *piśācas* of various form, which harass the pregnant women and the charms against them.

(iv) Charms against the serpents and serpent-bite: A charm to cure the poison of the serpents is given to Kaśyapa by Prajāpati (1.18.11). Kaśyapa in the AV is interested in the medical practices. He first produced the *pratisara* amulet for removing diseases and enemies (AV. 8.5.14). By means of this secret charm to cure the serpent's poison, Kaśyapa revived a tree, which was bitten by Takṣaka, the king of the serpents (1.39.9). This *vi-aharī vidyā*³⁰ of Kaśyapa appears to be the same as the charm against the poison of the serpents mentioned at the AV 5.13. Garutman the traditional seer of the hymn is also Kāśyapa, the son of Kaśyapa. The Mbh also refers to the boon, that all serpents would be the victims of Garutman (1.30.12). In the snake sacrifice (*sarpaśastra*) of Janamejaya, the serpents of themselves fell in the fire as soon as they were invoked by the charms with their names. Takṣaka did not come, when he was invoked by the charms. So Śaunaka asks whether the charms (*mantra-grāma*) had lost their effect against Takṣaka. It may be noted that the sage Astika, who stopped the serpent sacrifice was a Bhārgava (1.53.4). The Mbh 1.31.5-18 gives the names of the serpents. The AV also mentions a number of serpents.³¹ Airāvata and Takṣaka are some of the names common to both. The AV 10.4 describes a number of serpents. The AV 10.4.23 describes them as born of water and lightning. The Mbh 1.3.139 describes them as showering like clouds, urged by lightning. Thus both suggest their birth in the clouds and lightning. The AV 8.10.29 describes the visit of Virāj (the shining spirit) as a cow to the serpents. Takṣaka, the son of Viśāla became her calf. Dhṛtarāṣṭra Airāvata milked poison from her.³² The Mbh. speaks of Airāvata as the king of the serpents. The serpents shine on the top of the heaven (1.3.139-140). Arjuna married Ulūpī, the daughter of the serpent Kauravya, born in the family of Airāvata (1.206.18). The Mbh. often mentions the serpents and the charms against them. The Mbh. also mentions the pacificatory rites against the bite of scorpion or of stinging serpent (*vr̥ścika*) by means of the charm from the AV.³³ Karṇa calls Śalya as a scorpion and declares that his poison like a scorpion is lost

³⁰ Also compare AV 10.4 ; 4.6-7 ; 8.7-10 (particularly the word—*viśadūṣaṇi*).

³¹ I have treated this subject in detail in a chapter on the serpents and poisons in my book, 'The Foundations of the Atharvāṇic religion.'

³² Cf. 1.3.139-146.

³³ Cf. मद्रके सङ्गतं नास्ति हतं वृश्चिक ते विषम् ।

आथर्वणेन मन्त्रेण यथा शान्तिः कृता मया ॥ Mbh. 8.40-33*.

due to the pacificatory rite from the AV, performed by him. The AV(10.4.9,15) refers to the *vr̥ścika* in the charm to cure its poison.

(v) Ointment: The Gandharva Āṅgāraparna gives Arjuna the secret charm to see everything. The AV also tells us about an ointment and a plant which enables one to see the unseen things (AV. 4.20.19.43).

(vi) The milkings of Virāj : The Mbh. 7.69.10.27 tells of the milkings of the earth by the gods, men and other creatures. The AV 8.10.2.6 describes almost in the same way the milkings of Virāj conceived as a cow. AV.8.10.4 describes that Vainya, the son of Pr̥thu milked from Virāja agriculture and corn on which men live. The Mbh. 7.69.12 also refers to Vainya, who asked the earth to yield milk to those who want it.

(vii) Sañjaya glorifies Kāla as the creator and sustainer of all (1.1.187-190). The AV 19.53,55 glorifies Kāla as the supreme creator in two hymns in the same manner.

(viii) *The Kṛtyā* or witchcraft: The AV gives many hymns for effecting or counter-effecting the *kṛtyā*. Bhīṣma in the Śāntiparvan advises Yudhiṣṭhira that a king should always keep in his kingdom fourfold physicians, such as those who treat poison, surgery diseases and *kṛtyās* (12.69.59).^{*} The AV deals with all these topics. Consequently the physicians mentioned by Bhīṣma are those who are expert in the practices of the AV. The AV speaks of *kṛtyā*, worked out by the gods (AV.5.14.7). The gods in the Mbh. are described to have worked out *māyā* (*kṛtyā*) for deluding the two demons Sunda and Upasunda (1.201.12). The sage Cyavana produced *kṛtyā*, by offering oblations in Agni to kill Indra, who wanted to stop the offering given by Cyavana to Aśvins. The lustrous sage Cyavana produced *kṛtyā* in the form of of a demon by name Mada, who attacked Indra.³⁴ Indra then acknowledged the rights of Aśvins to drink Soma (3.124.18-19,125.5). Cyavana is a Bhārgava, who is the seer of eleven hymns in the AV. The charms from the AV are employed by the Brāhmaṇas to cheer up Duryodhana, who was greatly depressed owing to the humiliation caused by his defeat by the Gandharvas and his subsequent release by the Pāṇḍavas. The demons, knowing that their end was near due to impending death, of Duryodhana, who was fasting unto death began an Atharvaṇic rite in the *vitāna* fire.³⁵ The Brāhmaṇas well versed in the Vedic lore offered oblations and milk in Agni with the recitation of the charms of Brhaspati and Uśanas, found in the AV (3.239,19-21).³⁶ At the end of the rite *kṛtyā* presented herself before the demons, who asked her to take Duryodhana in the nether world (3.239.22-25). It is to be noted both Brhaspati and Uśanas belong to the family of the Bhrgvaṅgiras, the authors of the AV. On another occasion a woman came out of the magical rite (*kṛtyā*) performed by a sage, by name Raibhya, to kill Yavakṛita, the

³⁴ Cf. संस्तम्भयित्वा च्यवनो जुहुवे मन्त्रतोऽनलम् ।

कृत्यार्थं सुमहत्तेजा देवं हिंसितुमुद्यतः ॥ Mbh. 3.124-18.

³⁵ Nilakaṇṭha explains the word *vitāna agni* as 'one belonging to the AV and preserved on the nine sacred hearths.'

³⁶ Cf. बृहस्पत्युशनोक्तैश्च मन्त्रैर्मन्त्रविशारदाः । अथर्ववेदप्रोक्तैश्च याज्ञोपनिषदि क्रियाः मन्त्रजप्यसमायुक्तास्तास्तदा समवर्तयन् ॥ Mbh. 3.239-20.

son of Bharadvāja. The sage offered a tuft of hair from his head in the fire and the *krtyā* was effected (3.137.3). Janamejaya chose one Brāhmaṇa by name Somaśravas as his *purohita* to avert the sinful witchcraft (*pāpakṛtyā*), which was effected by Saramā, the divine bitch, since her son was struck by Janamejaya at the sacrifice performed by the latter. Somaśravas as a *purohita* was competent to avert any witchcraft except that which was effected by Mahādeva (1.3.10-15).

(ix) The AV (8.7.12) tells that the plants are capable of leading one to immortality. The Mbh tells that at the time of the churning of the milky ocean, there arose exudations of great trees and saps of many medicinal plants. This sap possessed immortal strength. The gods became immortal by drinking the sap of the medicinal plants (1.16.26).

(x) The AV often stresses the powerful effect of the speech (*vāc*) of the sages, who are the masters of the magical practices. Their speech brings about good or bad things. Their good words become the blessings and bad words the curses. The Atharvaṇic poet of the hymn 1.18 says that by his words he destroys all diseases of the body (AV.1.18.3); so his speech is powerful. There are a number of instances of such type. In the Mbh too we find such effect of the words of the sages. The sage, Śrīṅgin curses the king Parikṣit that since he had tied a dead serpent on the neck of his father he would be bitten by a serpent, being urged by the power of his speech (1.37.13).

(xi) The AV teaches that the practice of *tapas* leads one to the attainment of the mysterious power (AV.2.19-28 ; 19.28). In the Mbh. also the sage Dhaumya tells Yudhiṣṭhira to secure by means of *tapas* the miraculous power to feed the Brāhmaṇas (3.3.11-12). A number of incidents can be quoted from the Mbh. to this effect. The attainment of the spiritual power and using it for some good or bad purpose is the special teaching of the AV. In the Mbh. Pāṇdu explains to Kuntī that the Brāhmaṇas knowing the secret charms, practise severe penance for the sake of some personal gain (1.11.12). The serpents Vāsuki and Śeṣa practise penance to secure miraculous powers (1.32.2-6).

(xii) *Brhaspatisava* : The AV evolved a new technique of the symbolical sacrifices called *savas*. *Brhaspatisava* is one of the twentytwo *savas* or the Atharvaṇic sacrifices (AV.11.3 ; Kauśika 62-8 ; Keśava 9.64-66). In the Mbh. Vyāsa tells to the Pāṇḍavas, the various expiations for various sins. He further tells that a Brāhmaṇa drinking wine should offer the *brhaspatisava* ; then he becomes fit to go to the social gatherings (12.15.16).⁸⁷

(xiii) Yajña in the AV is identified with the Brahman (AV.19.42). The AV also speaks of the sacrifice in the form of Knowledge. The Mbh. in the Bhagavadgītāparvan speaks of such aspects of the sacrifice (6.26.24 ; 31.15).

(xiv) The AV gives a charm for branding the ears of the cows (AV 6.141). In the Mbh. Duryodhana counts the cattles by the marks on the ears (3.229.5). The AV supplies the magical rite for the practice of branding the ears of the cattles.

⁸⁷ The Śatapatha Brāhmaṇa considers that the Vājapeya sacrifice is the same as Brhaspatisava. This is an attempt of the Brāhmaṇa to identify and assimilate the Atharvaṇic practices in the orthodox Brahmanism. See SB. 5.2.1.19. I have treated in detail the subject of the Atharvaṇic sacrifice in my book, 'The foundations of the Atharvaṇic religion.'

(xv) The idea of the heaven is common to both the Mbh and AV. The Mbh. mentions the paths called the *devayāna* (3.243.3). The Mbh. also mentions the various *lokas* or the worlds. In the gardens of the gods on the mountain called Meru, there is no heat, no cold, no disease, nor old age. Above these there are the worlds of Indra. Above these worlds there are the worlds of Brahman. The men there enjoy the company of women (3.247.8.25, and AV.4.34). The Gopatha Brāhmaṇa 1.5.24 of the AV refers to the Brahmaloka as the topmost region in the heaven where the Atharvāṅgirasas go after their death. The AV (4.34.2) also tells that in the heaven the departed souls can enjoy many women, as their generative organ is not burnt by cremation fire.

(xvi) The science of archery and the practice of the magical missiles (*astravidyā*) : The Dhanurveda is a subsidiary branch of the AV according to the tradition. In the AV we find sufficient testimony to corroborate this tradition. The Atharvaṇic teachers such as Gautama Paraśurāma, Droṇa and Aśvatthāman are adept in the science of archery and *astravidyā*. The *astras* are the magical missiles, which bring about mysterious effect. The word *māyā* (miraculous power) is associated with the use of missiles (7.98.46). The word *śakti* (power) is also used to designate the *astra*. In a fight between Yudhiṣṭhira and Droṇa, Yudhiṣṭhira hurled a *śakti* against Droṇa. The *śakti* is described as having golden handle and having eight bells attached to it. It is a formidable missile, capable of cutting the mountain (7.106.29). The AV also describes the *kṛtyā* capable of miraculous power in hitting the enemies (AV. 10.1). The *astras* of the Mbh. are the same as the *kṛtyas* of the AV made more effective and more disastrous. The practice of the *astras* was thus hereditary in the family of the seers of the AV, the Bhṛgvaṅgirasas. Bharadvāja taught the *astravidyā* to Drupada and Droṇa (5.149.13). Of all the Brāhmaṇa families represented in the Vedic and epic literature the Bhṛgvaṅgirasas alone practised, preserved and imparted to others this knowledge. Droṇa ṅgīrasa was expert in the science of archery and magical missiles. He surprised the young Kuru princes by taking out of a well a small piece of wood, by means of an arrow charged with the magical qualities (1.122.16). Arjuna was taught all *astras* by Droṇa (1.125.19-20). Arjuna learnt the fire missile (*agnyastra*) from Droṇa, who got it from Agniveśya. Agniveśya got it from Brhadradvāja, who secured it from his father Bṛhaspati. Thus such missiles were preserved as the traditional treasure in the ṅgīras family (1.158.26-27). In the Mahābhārata war, both parties were equipped with the *astravidyā* taught to them by their ṅgīras teachers. The knowledge of missiles was secured by Karṇa from Paraśurāma. Karṇa describes it as the *brahman* (8.42.9). Paraśurāma taught Karṇa the charms, which are called Ātharvaṇa, for killing the enemies.³⁸ Thus we can say that the skill shown by the Kuru princes in the use of the *astras* on the battlefield, is the direct result of the knowledge which they received from their Bhṛgvaṅgīras teachers, the seers of the AV. The AV contains a number of charms for deluding and defeating the enemy. The AV (3.1-2 ; 6.65-67) gives the charms for deluding the enemy and making them helpless.

³⁸ Cf. रामादुपात्तेन महामहिम्ना ह्याथर्वणेनारिविनाशनेन ।

तदर्जुनास्त्रं व्यधमहन्तं कर्णस्तु बाणे निशितैर्महारमा ॥ Mbh. 8.90-4*.

It is possible that the Atharvaṇic charms were used for the purpose of the magical missiles, as Karna directly mentions that his *astravidyā* was called Ātharvaṇa and which was given to him by Paraśurāma, the Ātharvaṇa teacher.³⁹

(xvii) Armour (*Varman*) : Drona ties on the body of Duryodhana an armour to protect him against the arrows of Arjuna. Drona tells that the armour would be a wonder among the archers (7.94.33-34).^{*} Drona the most learned Brāhmaṇa desired to cause surprise in the warriors on the battlefield, muttered some charm and put the armour on the body of Duryodhana (7.94.35,39).^{*} Drona narrating the history of the charm and the armour, tells that they were given to Śakra by Śiva to kill Vṛtra, who was the *krtyā* (witchcraft) of Tvaṣṭṛ. Indra then gave it to Aṅgiras, who gave it to Brhaspati, the master of the charms. From him it came to Drona (7.94.49-68).^{*} The AV.7.118 gives a charm for putting on the armour.

(xviii) The sword and the axe : Not only the sciences of archery and the magical missiles (*astravidyā*) were traditionally preserved by the Atharvaṇic sages, but the sword and axe also were first secured by them from the divine source. Bhīṣma, while giving the origin of the sword, tells that from Rudra it came to Bharadvāja Aṅgirasa, who gave it to Drona (12.156.65-81).^{*} The axe was first given to him by Mahādeva, who was praised by him with his 1000 names. From him he got the axe and the divine missiles. It is on account of the axe that Paraśurāma (Rāma with the axe) is so called (13.18.11-13).^{*}

(xx) The Battle rites (*sāṅgrāmikakriyā*) : The AV treats of the battle rites also. The *purolīta*, who was expert in the Atharvaṇic practices, used the battle rites for securing success for his royal patron. The battle drum and battle chariots were charmed to possess miraculous power (AV. 6.126,125). On the day, when Arjuna declared to kill Jayadratha, he mounted on a chariot, which was charmed by means of the battle rites to secure success.⁴⁰ Yudhiṣṭhira protected his great army which was guarded by the sacrifices and muttering of magical charms (5.140.8). In fact the whole battle is identical with the performance of a sacrifice which has got miraculous power and which is rightly called the *śastra-yajña* (5.139.129-57).

(xx) The arrangement of the army (*vyūha*) : The Atharvaṇic teachers possessed the knowledge of the magical warfare, archery and other weapons. They also possessed the knowledge of the tactical arrangements of the army. In the battle with Bhīṣma, Dhṛṣṭadyumna was helped by Arjuna, who arranged the army in the form of *krauñcārūṇa vyūha*. This arrangement of the army was first designed by Brhaspati Aṅgirasa, who instructed it to Indra, in the fight with the demons. It is but natural that Drona Aṅgirasa should have taught this traditional knowledge about the *vyūhas* to his pupils (6.46.39-40).

(xxi) The assembly of Yama : The Mbh 2.8 describes the kings in the assembly of Yama, the god of Death. The AV. 3.29.1 also speaks of the assembly of Yama, where the kings are its members. These

³⁹ Supra.

⁴⁰ Cf. जैत्रैः सांग्रामिकैर्मन्त्रैः पूर्वमेव रथोत्तमम् ।

अभिमन्त्रितमर्चिष्मानुदयं भास्करो यथा ॥ Mbh. 7.84.16.

kings charge one-sixteenth of the religious merit of every person, who is admitted in the realm of Yama, after his death. In this connection it may be noted that the Bhṛgvaṅgirasas, the seers of the AV, sponsored the worship of the Pitr̥s. They are described as the most eminent Pitr̥s. Yudhiṣṭhira asks Bhīṣma about the state of ancestor worship, when Bhṛgvaṅgirasas lived (13.91.1).*

(xxii) The *purohita* (the officiating priest): The Atharvaṇic priests primarily functioned as the priests in the families of the householders and at the court of the kings. The Gopatha Brāhmaṇa remarks that only those Brāhmaṇas, who know the Bhṛgvaṅgiras Veda (the AV) deserve to be the *purohitas*. But this claim is not satisfactorily substantiated from the evidence in the other Vedic works.⁴¹ However, it can be easily admitted that the knowledge of the Atharvaṇic practices was absolutely necessary for the functions of the *purohita*. The AV taught the popular religious practices, making an appeal to the lower strata of the society, at the same time they won the royal favours by making their place absolutely necessary at the royal household. His practice of magic and the knowledge of magical warfare made him indispensable for the kings. In fact some of the kings identified themselves with the families of their *purohitas*. Siddhārtha the founder of Buddhism is styled as Gautama and Āṅgīrasa.⁴² Brhaspati Āṅgīrasa stands for the Brāhmaṇas and Indra for all the Kṣatriya (AV.15.10.4-5). Brhaspati is the *purohita* of the gods, having Indra as their lord. The Ātharvaṇas, following the tradition of their illustrious 'Father'⁴³ became the officiating priests of the Kṣatriya kings. In the Mbh. the Ātharvaṇas figure as the teachers of the Kuru princes. The Mbh. often speaks of the necessity of having the services of an officiating priest for a king. Bhīṣma while narrating the dialogue between Aila and Kaśyapa, tells to Yudhiṣṭhira that a king should appoint a Brāhmaṇa well-versed in all charms as his *purohita* (the officiating priest) (12.73.1-33)*. On another occasion Bhīṣma tells to Yudhiṣṭhira the qualifications for the post of the *purohita*. He points out that the *purohita* must be well-versed in the Atharvaveda, the other vedas, *kalpa* and *jyotiṣa*.⁴⁴ But particularly he must be adept in the practices of the AV (13.10.38).⁴⁵ The office of the *purohita* was hereditary. The *purohita* used to perform in the royal household, the recitation of the auspiciousness of the day (*puṇyāhavācana*) religious rites (*dharma-kṛtya*) and pacificatory sacrifices (*sāntihoma*) (13.10.3-62).* The AV supplies the charms for all these functions. On the first day of the Mbh. war, the *purohitas* increased the morale of the people on his side by condemning the enemy and devising means for his destruction. By means of utterance of the charms and use of the medicinal herbs they performed auspicious rites (6.22.7). The AV gives a number of rites, which ensure success in the battle. (AV. 7-90 ; 5.20.21 ; 3.1.2.). The *purohita* declares that the king whose *purohita* he is, is bound to be victorious for ever (AV.3.19). He is equipped with missiles more formidable than the *vajra* of Indra (AV. 3.19.4). In addition to duties of the *purohita* in peace and war, he is

⁴¹ See Bloomfield, the Atharvaveda. Introduction, p. ixviii.

⁴² See Dictionary of Pali proper names by Malalasekara, Vol. I, p. 20 and also see the article on Gotra by R. Fick, ERE, Vol. vi, p. 353, ff.

⁴³ Cf. RV 2.24.9.

⁴⁴ *Kalpa* here may stand for the *dharma*, *gṛhya* and *śrauta* rites.

⁴⁵ Cf. अथर्ववेदे वेदे च बभूवर्षिः सुनिष्ठितः ।

also expected to act as an ambassador at the foreign courts. Drupada, on behalf of the Pāṇḍavas proposes to send a *purohita* to the court of the Kauravas. The *purohita* at his court is described as a highly intelligent person and of firm mind. His intelligence is not inferior to that of Śukra and Aṅgiras (Bṛhaspati). Both these authorities are the members of the Bhr̥gvaṅgivas family (5.6.3). The *purohita*, thus occupying a unique position at the court of the king, can sometimes work evil also. In the kingdom of Lomapāda, the king of the Aṅgas, there was no rain for twelve years due to the vicious magical practices of his *purohita* (3.110.19-21). But the general tendency in the kings is to rule long only with the lead of his *purohita* (1.159.22). The Gandharva, by name Aṅgārāparṇa, tells to Arjuna that a king, who is led by his *purohita* can alone conquer the demonic creatures, who can be conquered at night. So a king should appoint a *purohita* for the benefit of his subjects (1.159.16 ; 1.161.14).

(xxiii) The greatness and glorifications of the Brāhmaṇas : Bhīṣma glorifies the Brāhmaṇas and points out their greatness (13.35.36).* The Mbh. abounds in the glorification of the Brāhmaṇas. Yayāti admits that if a Brāhmaṇa is enraged, he destroys even cities and kingdoms (1.76.24). Vinatā advises Garuḍa her son not to kill a Brāhmaṇa (1.24.3.5). The AV also emphatically declares that if a Brāhmaṇa, his wife or his cow is tortured, even the king in that country comes to grief (AV. 5.18.19).

(xxiv) Śiva and Vāsudeva worship : While praising Śiva with his 1000 names, Taṇḍin points out that Śiva has the head in the form of the Atharvaveda. (13.17.91).* The AV also describes Skambha, the Highest Brahman supporting all in the same manner. The Atharvāṇic poet makes Atharvāṅgiras Veda the mouth and the eyes of Skambha (AV.10.7.18 ; 20,34). The Mbh identifies Rudra (Śiva) with Kāla. Rudra discharges arrows charged with the ferocious spirit of the Bhr̥gvaṅgirasas against his enemies (8.34.51).* When Śiva attacked the three cities of the Assuras, the Atharvāṅgirasas guarded the two wheels of his chariot (8.34.44)*. Thus the AV and its seers are closely connected with the worship and glorification of Śiva. Upamanyu, while describing the glories of Mahādeva says that the followers of the R̥gveda praise him with the *ṛcs*, those of the Yajurveda offer sacrificers to him, those of the Sāmaveda with their *sāmans* praise his glory; but the followers of the Atharvaveda praise him as the Highest Brahman, which is the same as the Truth and the Eternal Law (13.16.46).* Similarly the worship and the glorification of Vāsudeva are sponsored by the Bhr̥gvaṅgirasas, the seers of the AV. Mārkaṇḍeya Bhārgava describes Govinda as the greatest wonder (6.64.2). Bhr̥gu speaks of him as the God of all gods, the Penance of all penances, and the *yajña* of 11 *yajñas* (6.64.3). Dirghatamas Gautama first named Vāsudeva as Keśava and gave currency to that name (12.341.55-56).*

(xv). Atharvan and Agni : The RV and the AV, as we have seen tell that Atharvan first produced Agni and employed him in the sacrifice. The Mbh. in the Āraṇyakaparvan (3.207-221) describes the relation of Agni with Aṅgiras and Atharvan. Mārkaṇḍeya Bhārgava narrates this account to Yudhiṣṭhira. The sub-parvan is named as Aṅgirasa. We are told that Agni being tired on account of carrying oblations to the gods in the sacrifice, and afraid of this exhausting task hid himself, in the waters. The gods searched in vain for him. He came to Atharvan

and requested him to do his job of carrying oblations in *yajña*. Thus saying he went elsewhere (3.212.6-9). The fish betrayed his stay in the waters. He again came to Atharvan, who on behalf of the gods repeatedly asked him to resume his duty. But he could not accede to it. Being exasperated, his body was withered. The fierce penance produced by the Bhṛgvaṅgirasas to revive Agni, made him (Agni) still more afraid of them, and he disappeared in the waters once more. The whole world, being thus devoid of Agni, approached Atharvan, who was worshipped by all gods and sages. Atharvan then churned him out of the ocean and made him do his job (3.262.15-19). Thus he spread the cult of Agni to all places, on the banks of the five rivers, except Indus and along the rivers like Narmadā, Godāvarī, Veṇṇā, Bhīmā, Kāverī, Kṛṣṇā and Śoṇa (2.212.20 ; 24). It thus seems that the exhaustion and withering of Agni and his disappearance refers to the decline of the religion of sacrifice. His approach to Atharvan indicates that Atharvanic religion was spreading from the north to the south, from the land of the five rivers to the Deccan table-land. This is thus the spread of the Atharvanic religion of Agni. It is to be noted that at the crucial time when Agni (sacrificial religion) was lost, Atharvan and other members of the Bhṛgvaṅgiras family led and directed the Aryan religion.

I have elsewhere shown how preponderating the Atharvanic or Bhṛgvaṅgiras influence is seen in the 1st and 7th *kāṇḍas* of the Rāmāyaṇa, which are added later on to the main bulk of 2-6 *kāṇḍas*.⁴⁶

It may also be noted that the present version of the Manusmṛti is the version of Bhṛgu. We can thus estimate the influence of the AV and the Bhṛgvaṅgirasas in the literary and religious activities from the RV down to the epics. The redactions of the Mbh, the Rāmāyaṇa, the AV and some portion of the RV form the literary activity of the Ātharvaṇas, or the Bhṛgvaṅgirasas, the seers of the AV.

VIII. Retrospect

We have seen the position occupied by Atharvan and the AV from the RV to the epics. The seers of the RV look upon the seer Atharvan as the institutor of the sacrifice. This sacrifice seems to be of the simplest form. Gradually Atharvan introduced the practice of offering Soma mixed with milk. Atharvan is one of the *Pitṛs*. Indra, the great god of the Aryans depends on his firm support. The Atharvans were quite respected priests, since they officiated at the sacrifices of the kings, and received priestly fees. But they were not the prominent seers of the RV. In the RV we find the families of Gr̥tsamada, Viśvāmitra, Atri, Vāmadeva, Gautama, Bharadvāja, Vasiṣṭha, Kaṇva and Āṅgirasas in the stray hymns of the 1st and 10th *maṇḍalas* as the most prominent among others. It is noteworthy that a number of hymns are attributed to the Āṅgirasas in the 1st and 10th *maṇḍalas* of the RV, which are not composite in character like the 2-7 *maṇḍalas*. Even in these composite *maṇḍalas*, the Gr̥tsamadas, the Bharadvājas, the Vāmadevas belong to the family of Bhṛgvaṅgirasas. Thus among the seers of the RV the descendants of the family of the Bhṛgvaṅgirasas

⁴⁶ See my paper on the authorship of the Rāmāyaṇa : Journal of the University of Bombay, Vol. XII, Part II, Sept. 1943.

play an important part. Atharvan does not figure as a seer of the hymns of the RV, like Bhṛgu and Aṅgiras, who belong to the pre-Ṛgveda times. Their descendants, mentioned above figure prominently in the making of the Ṛgvedic religion, which consists in offering oblations in Agni. This was the public religion of the Aryans. But in the household religion of the AV, Aṅgiras, Atharvan and Bhṛgu figure prominently. Also there figure in the AV, a number of charms connected with Bharadvāja, Kaṇva, Kaśyapa, Agastya, Vasiṣṭha and Viśvāmitra. It thus appears that the worship of Agni which was started by Aṅgiras, Bhṛgu and Atharvan resulted into the two aspects of the Vedic religion, the early sacrifice and magic. The hymns of the AV were composed for the other aspect of the Vedic religion. As regards the common seers of the RV and AV, we may say that the Vedic seers practised both sacrificial and magical religion in the public and private life respectively. Some members of these families gradually specialised in different aspects of the religion. In the collection of the Ṛgvedic hymns, those hymns, which pertained to the sacrificial religion were collected ; while those pertaining to magic were not cared for, as their use was restricted to the private life of the Vedic Aryans. Some hymns of the extant AV are as old as the RV, though the majority of them bear the appearance of being late. The Brāhmaṇas recognise it as the fourth Veda. The Brāhmaṇas incorporated the element of magic in their religion of sacrifice. Thus there appear to be two groups among the Brāhmaṇas, viz., the orthodox Brāhmaṇas preaching the religion of sacrifice and the Ātharvaṇas (including the descendants of Bhṛgu and Aṅgiras), who sponsored the household (*grhya*) religion and who were not very much respected by the orthodox Brāhmaṇas. The absence of the mention of the AV in the RV seems to be due to the apparently insignificant character of the AV, as it was practised mainly in the villages. The kings realising the importance of the magical practices employed the services of the *purohita*, who knew magic. On the whole, the practice of the Atharvaṇic religion was not much favoured by the respectable people of the Vedic society. But as the religion of sacrifice came down with its glory, the household religion (*grhya dharma*) took its place. The Atharvaṇic *purohitas*, connected as they were with the royal families, indulged in the philosophical discussions as the Kṣatriya kings took lead in the philosophical thoughts. This explains the presence of a number of the philosophical hymns in the AV. On account of this association with the kings as their *purohitas* they came to know of their geneologies and legends, more intimately than others. They were also the champions of the cause of the Brāhmaṇas. They magnified their power and abilities to maintain their position at the court of the Kṣatriya kings. Their legends and the legends about the kings did not find real scope in the sacrificial religion of the Brāhmaṇas. They were preserved in the *itihāsa*, *gāthās*, *narāsaṃsis* and popular ballads. All these found a fitting place in the great epics viz., the Mahābhārata and the Rāmāyaṇa.⁴⁷ That is why we find the epics, profoundly charged with the Atharvaṇic ideology and teachings. The Mbh is an epic of growth. This growth was influenced by the Atharvans who belong to the family of the Bhṛgvaṅgirasas.⁴⁸

⁴⁷ See my paper on the Authorship of the Mahābhārata, B.O.R.I. 24.

⁴⁸ An instance of such influence can be seen also in the southern recension of the Mbh. (12.73) which contains a long interpolation glorifying the AV and Brhaspati. See Hopkins, *Epic Mythology*, p. 181.

BHAṬṬA NĀYAKA'S THEORY OF RASA AND CENSURE OF DHVANI AS REVIEWED BY ABHINAVAGUPTA

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A STRIKING phenomenon in the history of Sanskrit Literary Criticism is the over-abundance of compendious authors who wrote their treatises after the manner of *śāstrakāras* and who sought to analyse literature and formulate rigid rules for the guidance of professional poets and critics. Since poetry cannot be so summarily explained in terms of so many cut-and-dried rules, a modern student is apt to conclude that the essential problems of literature were missed completely by the ancient Sanskrit theorists. But this impression will have to be revised when he reads the works of strikingly original authors like Ānandavardhana and Kuntaka, who not only show an awareness of these problems, but propose very satisfactory solutions to them. But unfortunately, the works of such brilliant and original literary critics who dared to differ from the established conventions of the day, were subjected to such neglect for centuries that most of them have been lost for ever. Their very merits hastened their oblivion. Bhaṭṭa Nāyaka's *hṛdayadarpaṇa* and Bhaṭṭa Tauta's *kāvya-kautuka* are two such masterpieces of criticism whose loss to Sanskrit Poetics can never be made up. In the absence of the books themselves, we have to fall back upon stray quotations found in other texts and commentaries to form some idea about them. In this connection, we receive immense help from Abhinavagupta whose commentaries on the *dhvanyāloka* and the *nāṭyaśāstra* are so unlike the ordinary run of commentaries in Sanskrit. They supply us a fund of authentic information on all such matters instead of being merely vague or discursive. In this paper an attempt is made to reconstruct Bhaṭṭa Nāyaka's theory of *Rasa* and his censure of *Dhvani* on the basis of the quotations recorded in Abhinavagupta's *dhvanyālokalocana* along with his comments on them.

There are numerous references to Bhaṭṭa Nāyaka's *hṛdayadarpaṇa* in Mahimabhāṭṭa's *vyaktiviveka*, Mañkhuka's (Ruyyaka's?) commentary thereon, Hemacandra's *kāvyañusāsana*, Jayaratha's commentary on *alaṅkārasarvasva*, etc., besides a number of quotations to be found in Abhinavagupta's *locana*.¹ According to the *rājatarāṅgiṇī*,² he lived in the period of Śaṅkaravarman (883-902 A.D.), which would imply that he was nearer to the time of Ānandavardhana than to that of Abhinavagupta. He is the one critic whom Abhinavagupta mentions by name again

¹ Cf. P. V. Kane, *History of Alaṅkāra Literature*, pp. lxxvii ff.

² V. 59.

and again, whose statements he quotes in full and refutes. From Abhinavagupta's frequent references to Bhaṭṭa Nāyaka in his commentary on Bharata's *nāṭyaśāstra*, it is clear that the *hrdayadarpaṇa* contained a constructive exposition of Bharata's theory of *Rasa* and other important topics besides a destructive criticism of the *dhvanyāloka*.³ That Bhaṭṭa Nāyaka was a reputed writer is proved beyond doubt by the fact that even Abhinavagupta quotes many of his statements with approval,⁴ and even when he differs from him, gives the view of Bhaṭṭa Nāyaka *in extenso* before refuting it.

Bhaṭṭa Nāyaka's greatest contribution to Indian poetics is his masterly exposition of *Rasapralīli*. He begins by pointing out the inadequacy of earlier views on *Rasa*.⁵ He points out that *Rasa* is not apprehended either as existing in another or as arising in oneself. The first alternative implies that *Rasa* already exists in some other person and in the process of inferring it as such, one derives aesthetic delight. The second alternative presupposes that *Rasa* is produced for the first time in the mind of the spectator (or the reader). Before taking up for criticism Ānandavardhana's theory of *Rasa-dhvani*, Bhaṭṭa Nāyaka exposes the drawbacks in these two earlier views. Regarding the first view he points out that if the locus of *Rasa* happens to be someone other than the spectator, then, the relationship of the spectator with *Rasa* would be one of strict neutrality (*tāṭasthya*). In other words, the pleasurable experience of the spectator will be left unexplained if that experience should be supposed to be pre-existing in another—either the hero or the actor. The second view that *Rasa* is realised as being produced in oneself, is shown to be equally untenable. For by reading poetry containing the story of Rāma and Sītā how can one ever get the impression that *Rasa* is born in his mind for the first time? What is the purpose of the poet in describing the various *vibhāvas*, *anubhāvas*, etc.? Is it to kindle the *sthāyibhāvas* in the hero or to kindle the *sthāyibhāva* in the reader? Surely, the former alone must be regarded as the intention of the poet. Sītā, the heroine of the poem, is a *vibhāva* for Rāma, the hero, not the reader. Supposing one were to say that instead of the individual Sītā, a universalised idea of *Kāntāṭva* (wife-hood) can serve as a *vibhāva* in rousing the reader's instincts also, we have only to point out that even this would be impossible in poems where love between gods happens to be the theme. As a matter of fact, while enjoying a love-poem, no one necessarily thinks of his beloved. Further, the above statement that though Sītā in particular cannot be a *vibhāva* for the reader, the idea of a beloved wife as universalised can act as *vibhāva*, implies that this universalised aspect has close affinity to the experience of the reader. But how can superhuman deeds such as Rāma's bridging the ocean etc., have any affinity with human efforts? Since such exploits do not accord with the reader's actual experience, he cannot say that Rāma's *utsāha* or energy rouses his *sthāyibhāva* and produces *Rasa* in his mind. Nor can he say that remembrance of Rāma's *utsāha* produces *Rasa*, though not Rāma's *utsāha* itself, since there can be no remembrance of what

³ The suggestion of Dr. K. C. Pandey that *Sahṛdayadarpaṇa* was a second work of Bhaṭṭa Nāyaka does not appear plausible. *Vide*, his *Abhinavagupta*, pp. 129-30.

⁴ *Vide*—*Dhvanyālokalocana*, p. 39, p. 87 and 91-92.

⁵ For some of these earlier views, see *infra*.

has never before been cognised. Even if it be held that Rāma's *utsāha* might be cognised by *śabda* or verbal testimony, it does not in any way prove that *Rasa* results in the reader as a result of such cognition. Just as by directly seeing the amours of a loving couple (i.e., by *pratyakṣajñāna* of a *nāyakamithuna*) there arises no *Rasa*, but just its opposite, viz., embarrassment, so also, *smṛti* or *anubhava* of Rāma's exploits does not produce *Rasa* in the reader. Moreover, if one holds that *Rasas* are produced in the reader, it would mean that actually misery is produced in his mind by reading pathetic descriptions; and if that were true, who would ever court misery by reading or witnessing tragedies and tales of woe? Hence it follows that *Rasa* is cognised neither as having existence elsewhere nor as being literally produced in one's own mind.

Having thus set aside the earlier views about *Rasa*-realisation, Bhaṭṭa Nāyaka turns to a refutation of Ānandavardhana's position :— He finds fault with the latter's statement that *vyāgya* and *vācya* are related to each other precisely like a pot and a torch which illumines it (*Ghaṭapradīpa-nyāya*).⁶ An illumined object like the jar can exist apart from the light that illumines it. The jar is there even before the torch is brought. In the same way one cannot say that *Rasa* already exists before it is suggested by the *vibhāvas*, etc. One might say that though *Rasa* does not pre-exist in its final form it can be taken as pre-existing in a latent form, (*śaktirūpa*). And it would mean that various degrees are possible in the experience of *Rasa*, that *Rasa* differs from work to work in degree though not in kind. Just as the degree of brightness in a torch affects the perception of a jar, so also the degree of *vibhāvas* etc., will have to affect the experience of *Rasa* and just as the brightest light will ensure the clearest perception of the jar, so the most elaborate treatment of *vibhāvas* etc., alone will have to condition the fullest experience of *Rasa*. But this is not true since it contradicts the universal experience of *Rasa* as one and indivisible. Moreover there would be the same difficulties as in the views already examined, in so far as *Rasa* is supposed to exist—though in a latent form—either in someone else or in oneself. Bhaṭṭa Nāyaka, therefore, concludes his criticism of all these views about *Rasa* with the pointed remark that *Rasa* is neither apprehended, nor produced, nor suggested by *Kāvya*.

Having thus cleared the field of all misconceptions, Bhaṭṭa Nāyaka sets forth his own solution to the problem of *Rasa*-realisation in poetry. According to him words in poetry come to be invested with a peculiar three-fold significance—The first is *Abhidhāyakatva* or conventional denotation; the second is *Bhāvakatva* or the power to universalise and it is associated with *Rasa*; and the third is known as *Bhōjakatva* or the power to yield delight and it relates to the *Sahridaya*. If the power of denotation alone sufficed to explain the peculiar charm of poetry, then how is the difference between *śāstraic* maxims that convey more than one meaning and figures of speech like *śloṣā* (*Paronomasia*) to be accounted for? Mere difference in *vṛtti* or mode of verbal and syllabic arrangement is not enough to account for it. Even if it were enough, the

⁶ For a fuller treatment of this topic, Vide—my article, "Ānandavardhana's Theory of Dhvani", to be published in the Journal of the Ganganatha Jha Oriental Research Institute, 1948.

reason why cacophonous syllables (*śruti-duṣṭa*) should be eschewed in particular instances, will be left unexplained. Hence it is necessary that we should accept *Bhāvakatva* as a second *vyāpara* or function for literary words, over and above *Abhidhā* or primary denotation. This *Bhāvakatva* is related to *Rasa*, and it serves to impersonalise or universalise the personal *vibhāvas* etc., in the poem. It as a result of *Bhāvakatva* that all individualistic associations separating the spectator from the actor and the hero are unconsciously submerged. *Rasa* is thus *bhāvita* or released, not as existing somewhere outside or inside, but only in a general way, since all such discrimination is countered by the generalising power of *Bhāvakatva*; it is this idealised *Rasa* which is aesthetically enjoyed by the spectator through the third process of *Bhojakatva* or Delectability. *Bhojakatva*, again, is a unique process differing from *anubhava* (cognition), *smṛti* (remembrance) and *pratipatti* (inference). It has an essential three-fold influence—*druti* (melting), *visṭāra* (spreading) and *vikāsa* (illuminating) on the mind of the *Sahṛdaya*. The mind is constituted of three *guṇas* viz., *Rajas*, *Tamas*, and *Sattva*. The first leads a man into ceaseless activity, the second encourages indolence and it is the third which can procure him spiritual bliss; *Brahmānanda* or spiritual bliss can be had only when the influence of the other two qualities is completely suppressed, and *sattva* alone is allowed to shine out. The power of *Bhojakatva* in poetry takes the reader very near the goal of spiritual bliss. The active *Rajas* is melted and rendered powerless, and *Tamas* is allowed to spread; but by nature it cannot actively hinder the pure and unalloyed bliss of *Sattva*. It is because of the presence of *Tamas* that *Kāvyānanda* or aesthetic experience falls short of *Brahmānanda* or spiritual bliss. Thus *Bhojakatva* is the most important function pre-conditioned (*siddha*) in literature. The aesthetic delight of the *Sahṛdaya* is what matters most, not instruction (*vyutpatti*).⁷

Such is Bhaṭṭa Nāyaka's theory of *Rasa* quoted in full by Abhinavagupta. It will be seen that this theory unlike others, is quite sound practically, based as it is on the essential psychological response of the *sahṛdaya*. Abhinavagupta himself realises this fact and before attempting at a repudiation of Bhaṭṭa Nāyaka's theory, he clears the ground by proceeding cautiously. He is in complete agreement with Bhaṭṭa Nāyaka excepting for three of his statements. Firstly, Abhinavagupta believes, as against Bhaṭṭa Nāyaka, that *Rasa* is apprehended, that there is *pratīti* of *Rasa*. Secondly, he thinks that both the functions of *Bhāvakatva* and *Bhojakatva* can be brought under the more comprehensive function of *Dhvanana*. Here he takes objection to Bhaṭṭa Nāyaka's terminology rather than his theory. Thirdly, Abhinavagupta considers Bhaṭṭa Nāyaka's explanation of *Rasa* in terms of *druti*, *visṭāra* and *vikāsa* of *Rajas* etc., as inadequate. Reserving his criticism on these points to the end, Abhinavagupta proceeds to state the various views held about *Rasa*, in relation to *Nāṭya*.

⁷ See Dhv. *Locana*, pp. 180-183. Uttuṅgodaya in his commentary on the *Locana* summarises the position of Bhaṭṭa Nāyaka in the following verse :

व्यापारलिविधो बुधैरभिमतः काव्ये ऽ भिद्याभावना- ।

भोगोत्पादकतात्मना तदधिको नास्ति ध्वनिर्नाम नः ।

सिद्धाद्या व्यवहारभूमिषु विभावाद्यर्थसाधारणी- ।

कारात्मा त्वपरा निरर्गलरसास्वादात्मिकैवान्तिमा ॥ *Dhvanyāloka*, KSRI Edn., p. 79.

'Writers are seen to differ even about the nature of *Rasa* itself. Some (i.e., Lollaṭa and his followers) maintain that *Rasa* is found only in the hero (*anukārya*) whose actions are represented on the stage. The *sthāyī-bhāva* in the hero will itself come to be termed as *Rasa* at a later stage when it is heightened by *vibhāvas* etc. And we call it *Nāṭya-rasa* for the simple reason that it is employed in *Nāṭya*.

Others demur to this view and state that *Rasa* is found only in *Nāṭya* and not at all in the *anukārya*. Their reasons are as follows :—*sthāyībhāvas* and *vyabhicāribhāvas* are all propensities of the mind. Just as in a running current of water, new water takes the place of old every moment, these propensities also go on changing every moment. If there is a flood there is flood in the whole stream, not in portions of the current. In the same way either all the propensities are heightened simultaneously or remain as they were before. One propensity (say, a *vyabhicāribhāva*) cannot heighten another propensity (say, a *sthāyībhāva*). By gradual degrees the intensity of *sthāyībhāvas* like *vismaya* (wonder), *śoka* (grief) and *khrodha* (anger) slows down rather than increases. Such being the case, how can the *sthāyībhāva* in the hero, so increase in intensity by the interplay of other *bhāvas* as to be transformed into *Rasa*? Nor is it possible that *Rasa* can exist in the *anukartr* or actor; for if it exists in him already, why should he need the assistance of music and dance? It is not even possible that *Rasa* can exist in the spectator (*sāmājika*). Supposing it does arise in him, even then what guarantee is there that *camatkāra* or aesthetic pleasure alone is felt? On the contrary, in the case of *Karuṇarasa* (sentiment of pathos), the spectator will have to suffer grief. Hence this alternative too will not do. Then again, the very idea of representation of the original *sthāyībhāvas* in the hero is impossible since their range is unlimited. Representation is possible of the *sthāyībhāvas* only in one of their innumerable manifestations; and there can never be the certainty that the particular manifestation represented is the one which is always constant (*niyata*). And by such a representation of one particular, perhaps unessential, aspect of *sthāyībhāva*, what is the purpose gained? Nothing at all, since not even instruction can be had by the spectator who remains neutral while witnessing the representation. For all the above reasons it follows that *Rasa* is a kind of delectable apprehension (*āsvālarūpā pratipattiḥ*) found only in *Nāṭya* but based upon the actor's performance wherein *sthāyībhāva*, in its variable aspect (not in its constant, unchanging aspect) blends with *vibhāvas*, *anubhāvas* and *vyabhicāri-bhāvas*. This apprehension is different from remembrance of the hero's happiness in the past; it is delectable in itself. The basis for the apprehension of *Rasa* is none other than the actor who is identified with the hero by the spectator, and it is the spectator that enjoys *Rasa*. Hence *Rasa* is apprehended in *Nāṭya* alone, not in the hero.

Some others say that just as in the case of a painted horse the very imitation of the real horse becomes a source of pleasure, so also the very imitation by the actor (with the aid of histrionics), of the original *sthāyībhāva* in the hero, becomes a source of pleasurable experience. Hence the name *Rasa*, which literally means 'what is enjoyed.' And *Rasa* is enjoyed through *Nāṭya*.

• Still others hold that *vibhāvas* and *anubhāvas* themselves get the name of *Rasa* when they are successfully staged in so far as they get into

relation with the *sthāyibhāva* in the spectators as conditioned by the *vibhāvas* and *anubhāvas* that are staged. And when they thus affect the particular propensities in the spectator, he experiences unique joy. Hence staging itself (*Nāṭya*) should be looked upon as *Rasa*.

There are also other writers who regard that the locus of *Rasa* is identical with one or another of the following—(1) *Vibhāvas*, (2) *anubhāvas*, (3) *sthāyibhāvas*, (4) *vyabhicāribhāvas*, (5) the blending of the above, (6) the hero and (7) a conglomeration of all the above.

Such is the divergence of opinion amongst commentators about the real nature of *Rasa* even in the field of *Nāṭya*. Bhaṭṭa Nāyaka's theory is set forth with reference to *kāvya* or poetry in general. Abhinavagupta proceeds to point out that as a matter of fact there is no difference at all in the manifestation of *Rasa* between *Nāṭya* and *Kāvya*. Just as *Nāṭya* has got two essential aspects viz., *Lokadharmī* and *Nāṭyadharmī*, *Kāvya* also has two corresponding aspects. *Lokadharmī* is the naturalistic aspect in acting which tries to incorporate one's natural gestures in real life and which also allows for a variety according to the station of the men and women in question; *Nāṭyadharmī* is the conventional element which does not have any correspondence in real life. It is the conventional utilisation of music, harmony and rhythm by the actors.⁸ In lieu of *Lokadharmī* we have *svabhāvokti* in poetry; and in place of *Nāṭyadharmī* we have *vakrokti*; The three *Guṇas* viz., clarity, sweetness and floridity add grace to the *vibhāvas* etc., treated in poetry. Such being the case, there is no reason why *Rasa* in poetry should be regarded as being different from *Rasa* in *Nāṭya*. Though Abhinavagupta is prepared to concede for argument's sake that experience of *Rasa* in poetry may be different from that in *Nāṭya* inasmuch as the media are different, he cannot see any difference so far as the procedure (*sarāṇi*) of *Rasa*-realisation is concerned.

The several theories about *Rasa-pratīti* enumerated above therefore apply to poetry also though they have been formulated with particular reference to *Nāṭya*. And of them, Abhinavagupta points out that only the first (viz., Lollāṭa's) is open to the criticism of Bhaṭṭa Nāyaka that *Rasa-pratīti* is neither *sva-gata* nor *para-gata*. At the same time, he also shows how the fact of *Rasa* being a *pratīti* is common to all the views and Bhaṭṭa Nāyaka's denial of it is untenable. Abhinavagupta cites a counter-instance to prove the hollowness of the position taken up by Bhaṭṭa Nāyaka. Supposing there is something which has never been apprehended at all, a ghost for instance, then it cannot be made the subject of any discourse. But *Rasa* is not on the same footing as a ghost. It is not an apparition, but a real experience. Just as the genus of apprehension (*pratīti*) can include under it several

⁸ Cf. कवे च लोकनाट्यधर्मिस्थानीयेन स्वभावोक्तिवक्रोक्तिप्रकारद्वयेन लोकोत्तरप्रसन्न-
मधुरैजस्विशब्दसमर्थमाणविभावादियोगादियमेव रसवार्ता ।

स्वभावाभिनयोपेतं नानास्त्रीपुरुषाश्रयं नाट्यं लोकधर्मं ।

स्वरालङ्कारसंयुक्तमस्वस्थपुरुषाश्रयं नाट्यं नाट्यधर्मं ।

— *Kāyapraśaṅkāsāṅketa*, p. 75 (Mysore Edn.)

cf. also, Dr. V. Raghavan's article on *Loka-Dharmī* and *Nāṭya-Dharmī* (conventions and Idealism) of Bharata's stage, *Journal of Oriental Research*, Madras, Vol. VII.

species like perception, inference, verbal testimony, intuition and spiritual perception, each differing from the other because of difference in the means (*upāya-vailakṣaṇya*) leading up to each, so also *Rasa* can be regarded as another species of *pratīti*, called by various names, such as *carvaṇā* (relishing), *āsvādana* (tasting) and *bhoga* (enjoyment), since the means leading to *Rasa* are quite unique. The means that go to manifest *Rasa* are *vibhāvas* etc., which can touch a sympathetic chord in the heart of the reader.

At this point Abhinavagupta anticipates and answers a possible objection. If *Rasa* itself is a *pratīti*, to speak of the *pratīti* of *Rasa* would be absurd. Abhinavagupta admits that this is true and yet justifies such usages as '*Rasāḥ pratiyante*' on the analogy of usages like '*odanam pacati*'. Cooked rice is called *odana* and yet loosely, people speak of cooking of *odana*. In the same way the usage which makes it appear as though *Rasa* is an object of apprehension, rather than apprehension itself should be regarded as a loose and rambling usage which passes muster, though, strictly speaking, it is incorrect. *Rasa* is itself an apprehension. In *Nāṭya* it is unique because it is distinct from ordinary inference though inference becomes a means in the apprehension of *Rasa*; similarly, in *Kāvya* it is unique because it is distinct from other kinds of verbal knowledge though verbal knowledge does play a part in the apprehension of *Rasa*.

Abhinavagupta next takes up for criticism Bhaṭṭa Nāyaka's statement that superhuman exploits cannot touch any sympathetic chord in the heart of the spectators. He considers that the statement of Bhaṭṭa Nāyaka is a very daring one (*mahat sāhasam*) since it goes against the conclusions of *Patañjali*, the author of *Yoga-sūtras*, who says clearly that since desires are eternal, human propensities also which are inherited from birth to birth are without a beginning and limitless.⁹

Abhinavagupta then turns to a refutation of Bhaṭṭa Nāyaka's idea of *vyāpāras*. He says that in poetry there is only one *vyāpāra* which supervenes *abhidhā* and that is suggestion (*dhvanana*). He is not prepared to accept the two additional *vyāpāras* postulated by Bhaṭṭa Nāyaka. Abhinavagupta says that *Bhōjakatva* is nothing but another name of *Dhvanana* itself. And so far as *Bhāvakatva* is concerned, if it means promotion of *Rasa*, that function too can be brought under the category of appropriate usage of *Guṇas* and *Alaṅkāras*. Abhinavagupta states that there is nothing new in this idea to justify its being regarded as an independent function. But if it should mean an efficient cause of *Rasa*, Bhaṭṭa Nāyaka's own theory will be vitiated by the very defects he tried to avoid viz., the position that *Rasa* is produced.

Further, *Bhāvakatva* is said to be a *vyāpāra* of *Kāvya* by Bhaṭṭa Nāyaka. *Kāvya* consists of *śabda* and *artha*. Bhaṭṭa Nāyaka cannot say that *Bhāvakatva* is a function either of the *śabdas* alone or of the *arthas* alone, since in the ignorance of either, *Rasa* is not enjoyed. If he says that it is a function of both, then it would be identical with suggestion in fact and the difference will be only in name. Abhinavagupta

⁹ Cf. *Yogasūtras*, IV 9-10.

then proceeds to examine the implications of the word *Bhāvakatva* in the light of the *Mīmāṃsā* system and proves that ultimately the *vyāpāra* will be *dhvanana* alone and nothing else. According to the *Mīmāṃsakas*, all vedic injunctions refer to acts of duty and the verb in the imperative mood denotes *Bhāvanā*. *Bhāvanā* is the force of predication which contains three aspects—*Sādhya* (the end), *sādhana* (the instrument) and the *itikartavyatā* (procedure). Applying this principle to *Kāvya* one might say that *Kāvya* is the *Bhāvaka*, *sādhya* is *Rasa* and *Itikartavyatā* is the incorporation of appropriate *Guṇas* and *Alaṅkāras*. What then is the *karana* (or *Sādhana*)? It is nothing but *vyāñjakatva* itself. So even according to the *Mīmāṃsaka* conception of *Bhāvanā* involving a triple aspect, suggestion deserves to be recognised as the instrument. Hence there is no necessity for regarding *Bhāvanā* as one of the *Vyāpāras* of *kāvya*.

When suggestion is recognised as a significant *vyāpāra* in *Kāvya*, *Bhujakatva* also will be explained and hence it is superfluous. It is not the term *Kāvya* that brings enjoyment; enjoyment is a unique aesthetic experience brought about by a rending of the thick blinding veil of massive ignorance which covers the essentially blissful *sattva*. And this extraordinary experience can be explained only in terms of suggestion which includes *Bhujakatva* within itself. Further, the manifestations of *sattva* and other *Guṇas* being endless, any attempt at a rigid explanation of them in terms of *druti*, *vistara*, etc., are bound to be inadequate.

Finally, Abhinavagupta says that Bhaṭṭa Nāyaka is wrong in thinking that no moral instruction is possible from *Kāvya*. It is true that there is no direct instruction which takes the form—‘one must behave like Rāma’ etc., as in the case of *sāstras* and *itihāsa*. But enjoyment of *Rasa* itself is the highest training which can ever be given to one’s imagination.

Such is Abhinavagupta’s counter-criticism of the points raised by Bhaṭṭa Nāyaka in connection with the process of *Rasa*-realisation.¹⁰ It will be seen that there is no difference of opinion regarding the fact that *Rasa* is the most important element in poetry.¹¹ It is only round the term to be given to its mode of realisation that the scholastic controversy centres.

Besides this elaborate criticism of Bhaṭṭa Nāyaka directed against the theory of *Rasa-Dhvani* in general, stray sentences of Bhaṭṭa Nāyaka criticising particular statements in the *Dhvanīyāloka* are found scattered throughout the *Locana*. Thus in one passage quoted on page 39,¹² Bhaṭṭa Nāyaka points out that *Dhvanī* as a *vyāñjanā-vyāpāra*, though admitted for argument’s sake as an independent function, can constitute at best an element of poetry but not the soul of poetry. The soul of poetry is *Rasa* and a function of words cannot dislodge its status

¹⁰ Cf. Dhv. *Locana*, pp. 184-90.

¹¹ Cf. काव्ये रसयिता सर्वो न बाद्धा न नियोगभाक् । op. cit., p. 39.

¹² ध्वनिर्नामापरो यो नै व्यापारो व्यञ्जनात्मकः ।

तस्य सिद्धेऽपि भेदे स्यात् काव्येशत्वम् न रूपता ॥ Dhv. *Locana*, p. 39.

Cf. also op. cit., p. 52.

of being the soul. Abhinavagupta meets the objection by taking *dhvani* in the sense of 'what is suggested' (*dhvanyate iti*) so as to apply to *Rasa*; and he also points out that the other two categories of *vastu* and *alaṅkāra-dhvani* become significant only in relation to *Rasa*.

In another passage,¹³ Bhaṭṭa Nāyaka tries to show that the first instance of *vastu-dhvani* given by Ānandavardhana¹⁴ is not an instance of the play of suggestion, but only of the *Bhayānaka-rasa*. Abhinavagupta answers the objection by the witty observation that Bhaṭṭa Nāyaka is unconsciously supporting *Rasa-dhvani* in his zeal for denying *vastu-dhvani*.¹⁵ He also points out that the *Rasa* suggested is not *Bhayānaka* but *Śṛṅgāra*.

Ānandavardhana's second instance of *Vastudhvani*¹⁶ is also dismissed by Bhaṭṭa Nāyaka with the comment that the so-called suggested idea is only *śābda* or primarily denoted because of the gestures of the speaker and the context.¹⁷ Abhinavagupta points out that here again, Bhaṭṭa Nāyaka is lending unconscious support to *Dhvani* as a separate *vyāpāra* when he refers to the aid of the context, etc.¹⁸

Bhaṭṭa Nāyaka also seems to have urged that every sentence would be an instance of poetry if *Dhvani* were looked upon as the soul.¹⁹ Abhinavagupta disproves it by stating that only those instances which are rendered beautiful by the proper adoption of *Guṇas* and *Alaṅkāras* are regarded as poetry according to the *Dhvani*-theory.

In *Kārikā* I.13, the dual number of the word '*vyāṅkataḥ*' appears to have been criticised by Bhaṭṭa Nāyaka as insignificant.²⁰ Abhinavagupta meets the criticism by showing the special significance of the dual number.

13 यस्तु भट्टनायकेनोक्तम्-इह दृष्टमिहादिपदप्रयोगे च धार्मिकपदप्रयोगे च भयानक-
रमावेशकृतैव निषेधावगातः तदीयभीरुरीरत्वप्रकृतिनियमावगममन्तरेणैकान्ततो
निषेधवगल्यभावादिति तत्र केवलार्थसामर्थ्यनिषेधावगतेर्निमित्तमिति । —op.
cit., p. 68.

14 See Dhv. p. 52, - भम धम्मिअ etc.

15 Cf. किं च वस्तुध्वनिं दूषयता रसध्वनिस्तदनुग्राहकः समर्थत इति सुष्ठुतरां ध्वनि-
ध्वंसोऽयम् । यदाह- 'क्रोधोऽपि देवस्य वरेण तुल्यः इति । —Dhv.
Locana, p. 69.

16 See Dhv. p. 71, अत्ता एत्थ, etc.

17 यत्त्वाह भट्टनायकः —'अहमित्यभिनयविशेषेणात्मदशावेदनाच्छब्दमेतदपी'ति ।
Dhv. Locana, p. 72.

18 तत्राहमिति शब्दस्य तावन्नायं साक्षादर्थः ; काकादिसहायस्य च तावति ध्वननमेव
व्यापार इति ध्वनेर्भूषणमेतत् । —Loc. cit.

19 यदुक्तं हृदयदर्पणे-“सर्वत्र तर्हि काव्यव्यवहारः स्यात्” इति । —op. cit., p. 88.

20 तेन यद् भट्टनायकेन द्विवचनं दूषितं तद्वृजनिर्मीलिकथैव । —op. cit., p. 104.

In the instance of *arthāntara-saṅkramita-vācya-dhvani* given in the *Dhvanyāloka*,²¹ Bhaṭṭa Nāyaka says that the beauty is due to the interjections which bring out the excitement of the speaker, and no *dhvani* is instanced.²² Abhinavagupta's reply is that at least *Rasa-dhvani* is instanced since excitement is a *vyabhicāri-bhāva* of *vipralambha-śrīgāra*.

Some quotations cited by Abhinavagupta from the *Hydayadarpaṇa* show how Bhaṭṭa Nāyaka fully realised the intrinsic relation between *Rasa* and Poetry and how his theory of poetry took into account the peculiar processes whereby *Rasa* is manifested. He regards poets as the favourite children of the goddess of speech. She is said to shower her choicest gifts lovingly upon them even as the cow which yields the best part of her milk to the calf. In this respect *Rasa* in *Kāvya* is said to surpass even spiritual ecstasy. The *yogins* have to struggle hard before they can share the spiritual Bliss ; but *Rasa* in poetry is achieved by the poets without any struggle. It would appear as though *Vāk* herself runs to them with her choicest blessings as the cow towards its calf.²³ Unless the poet himself is fully permeated with aesthetic delight at the beginning, Bhaṭṭa Nāyaka says that he will not succeed in communicating it through his poem.²⁴ He further demarcates the province of poetry clearly from that of scripture and mythology in the following way : "It is the word which is exclusively important in scripture (*śāstra*) ; the meaning is more important than the word in mythology (*ākhyāna*) ; but in poetry both word and meaning become less important ; it is the *vyāpāra* (procedure) itself which is exclusively important."²⁵

From these stray quotations alone, we cannot form an adequate estimate of Bhaṭṭa Nāyaka. More often than not, in his zeal to make the statements of Bhaṭṭa Nāyaka look ridiculous, Abhinavagupta quotes them torn from their context, not even in full, but only in fragments. But even these insufficient data are enough to show that Bhaṭṭa Nāyaka was more than a mere carping critic of the *Dhvani*-theory like Mahimabhaṭṭa ; he was a constructive writer who formulated a new theory of poetry free from the defects he found in the *Dhvanyāloka*. His remarks on *Rasa* clearly bear testimony to his sound judgment and as the very title of his work shows, he claimed, not perhaps undeservedly, that he was holding up the mirror to the hearts of responsive readers. But as against the theory of Ānandavardhana, Bhaṭṭa Nāyaka's theory could not long hold its own and in course of time came to be consigned to the limbo of oblivion.

²¹ See Dhv., pp. 167-8.

²² यत्तु हृदयदर्पणे उक्तम् — 'इहा हेति संरम्भाथोऽयं चमत्कारः ।

—Dhv. Locana, p. 171.

²³ यदाह भट्टनायकः, — वाग्धेनुर्दुग्ध एतं हि रसं यद्भालतृष्णया ।

तेन नास्य समः स स्याद्बुद्धते योगिभिर्हि यः ॥ Dhv. Locana, p. 91.

²⁴ एतदेवोक्तं हृदयदर्पणे — 'यावत्पूर्णो न चैतेन तावन्नैव वमस्यमुम्' इति ।

—op. cit., p. 87.

²⁵ तेन यदाह भट्टनायकः —

शब्दप्राधान्यमाश्रित्य तत्र शास्त्रं पृथग्विदुः ।

अर्थतत्त्वेन युक्तं तु वदन्त्याख्यानमेतयोः ॥

द्वयोर्गुणत्वे व्यापारप्राधान्ये काव्यधीर्भवेत् ॥ —op. cit., p. 87.

THE SCIENTIFIC TERMINOLOGY OF DR. RAGHU VIRA

By DR. Y. G. LELE, D.Sc.

THE work of the Great English-Indian Dictionary undertaken by Dr. Raghu Vira and his colleagues is really a colossal one. The idea of preparing a dictionary of scientific terms which will be useful to all the languages of India is no doubt grand; but like an ideal which recedes from us as we make advance towards it, it is very difficult to be realised. The Indian languages have enormously developed, and though in their development they have drawn and still draw upon Sanskrit, the Mother of languages, the new words from the same old Sanskrit word or root are tinted by provincial colour and tradition. If therefore an attempt at a new terminology is to be made, strict adherence to the Sanskrit connotation and grammar must be followed.

Dr. Raghu Vira is conscious of the previous attempts made in various Indian languages ; and though he gives them few words of condescending praise, he ultimately, brushes them aside, as the words formed by them, according to him, "lacked flexibility and growth." The authors, he complains, had not even analysed English words into their formative elements. "They were no philologists. They did not know that words do not stand alone, that they have their relatives and associates, parents and derivatives, and that it is best to tackle many of them together." We will again later on revert to this analysis of formative elements of words during the course of discussion, and show that such analysis without the knowledge of the meaning indicated by them is sure to land us in grave errors.

Dr. Raghu Vira is also not satisfied with the existing rules of Sanskrit grammar. "At the very outset," he warns the reader, "it should be borne in mind that no grammar not even the excellent work of Panini, covers all the existing formations and usages. Now when the language is expanding . . . it becomes imperative to modify and supplement the ancient rules."

Such sweeping assertions, though they may be useful for propaganda, will not satisfy the scientific and scrutinizing mind without factual substantiation.

The fact is that Dr. Raghu Vira has not as yet given full thought to the formation of words. He has therefore asked his readers "to wait for some while before they get a complete account of their (of words) structure."

In the Introduction (Vol. I, pt. 1) Dr. Raghu Vira gives the General Principles which have been followed in forming the Indian words. Of these principles, we think, the second one is the most important and ought to have been followed with strict rigour. We reproduce that

principle: "Words are अन्वये significant. They lead you in the direction in which the thing or idea denoted lies; they point to some salient feature. They may ('should' should be) even be founded on the basis of an exclusive characteristic." The idea, the meaning is the life of a word and must be preserved. The form comes afterwards and has a secondary importance. But Dr. Raghu Vira is a philologue; to him form is more important of the two.

He further (Principle 9) tells us that "...old names are assiduously hunted out from the vast range of Sanskrit, Pali and Prakrit literature." Is it intended to be an appeal to Patriotism? Lucidity is also an important factor in forming terminology. A word unless it satisfies the requirements demanded by meaning and idea to be expressed, should not be chosen only because it is an old one of Sanskrit, Pali, or Prakrit origin. This is false patriotism blinding the clear vision of Science.

Dr. S. S. Bhatnagar in his Foreword assures the reader that "This first volume of the Great English-Indian Dictionary covers the field of Inorganic chemistry. The following volume will deal with the terminology of Organic chemistry, Biochemistry and Pharmacy. A special volume has been projected for Physical chemistry." But the Editor has a different scheme. According to him, "The Dictionary will appear in separate parts. Every major science will be allotted separate volume. The present volume (meaning Vol. I, pt. 1) contains names of elements, their symbols, and derivatives and compounds beginning with the names of elements. It also contains some of the well-known prefixes, suffixes and abbreviations. With the help of this material, it is possible to reproduce almost all chemical formulae. Verbs derived from the names of elements have been registered in Appendix I." Words "Volume" and "Part" are loosely used both by Dr. Bhatnagar and the Editor. The looseness on the part of the Editor is the more deplorable.

Dr. Raghu Vira does not make any distinction between "Inorganic," "Organic" and "Physical" chemistry, includes organic substances in pt. 1 of Vol. I and believes that what material is presented therein is sufficient to help to reproduce "almost all, chemical formulae." But simple words like "Acid," "Alkali" etc. are not included in the list.

Pt. 3 of Vol. I which is titled as "Chemical Apparatus" has 4 appendices covering 75 columns out of 117 leaving only 42 columns for the principal subject. "Miscellaneous" would have been a better title for the part, as the appendices with each other as well as with the main chapter have absolutely no connection whatsoever.

This is about the general scheme, or better want of scheme, of the Dictionary. We now come to the matter given therein which may for the purpose of review be divided into the following 4 heads. Of the proposed Dictionary pts. 1 & 3 of Vol. I, and Rasayan Praveshika (by Prof. Sadhu Ram) based on the terminology of the Dictionary is the only available material for the present for judging the merits of the new terminology.

- (I) Names of Elements.
- (II) Scientific Matter.
- (III) Word Formation.
- (IV) Incorrect Use of Sanskrit Words.

(1) *Names of Elements*

Dr. Raghu Vira divides 92 elements into 11 classes and applies different principles for naming elements of these different classes.

For the Class 1 he uses names that "are in use in India since ancient times." What is meant by "ancient" is not clear. If age is the only taste हिरण्य is older than स्वर्ण and has on that score better claim. If usage in the old Hindu Chemistry is to be accepted सुवर्ण should replace स्वर्ण, and वंग, त्रपु and नाग, सीस. Though त्रपु and सीस occur in शतरुद्रीय सूक्त (सीसं चमे त्रपुश्चमे) writers of Hindu Chemistry prefer वंग and नाग. अयस् is rarely used for iron. लोह is the name for it (लोहमस्य etc.). The same case with शुत्वारि. गंधक is commonly used. अंजन and नेपाली are never used as names of elements. They are sulphides of antimony and arsenic respectively. There are five varieties of अंजन

पंचांजनानि सौवीरं स्रोतो नीलं च पुष्पजम् ।

रमजं क्रमतो धूम्रमाषत्कृष्णं च भस्मम् ॥१९४॥

श्वेतं सिम्भं तथैतानि नदीशैलभवानि च ।

रसकामधेनु (पृ. २९६)—द्वितीये धतुसंग्रहपादि
चतुर्थेऽध्यायः ।

According to P. C. Ray (History of Hindu Chemistry 1902, Vol. I. footnotes on pp. 29, 30, 66). सौवीर, स्रोत and नील are all stibnite—sulphide of antimony. Metallurgy (सत्त्वपातन) of antimony was also known in ancient times. रसकामधेनु gives the following process :

अथांजनसत्त्वपातनम्

सत्त्वं शिवासमं चैषां रसपुष्पजवर्जितम् ॥२०७॥

तयोः शुद्ध्यैव कर्माणे नेत्ररोगहराणि च ।

रसरत्नाकरे

सौवीरं तीक्ष्णचूर्णं च मूषायां मंधमेतमम् ॥२०८॥

हठाद्ध्माते भवेत्सत्त्वं वरनागं तदुच्यते ॥

The author of रसरत्नमुच्यते as quoted by P. C. Ray (*ibid.* p. 66) takes नालांजन instead of सौवीर; otherwise the process is the same. Here we get the correct word for antimony वरनाग which is used by V. G. Desai in "The Ancient Chemistry of India" (p. 10). We wonder how the learned Editor of the Dictionary missed it.

Re: नेपाली it is one of the names of मनःशिला which is realgar (रसाणव Edited by P. C. Ray, Index p. 52). To quote रसकामधेनु again

अथ मनःशिलानामानि, मरुमधेनौ—

नागमाना रोचनी च काला च रसनात्रिका ।

नेपालिका विगन्धा च श्यामाङ्गा करवीरिका ॥१७४॥

मनःशिला or नेपालिका occurs as

रक्ता पीता तु खण्डाख्या पूर्वपूर्वा स्मृतोत्तमा ॥

रसकामधेनु further quotes from रसरत्नाकर the metallurgical process for arsenic (मनःशिलासत्त्वपातनविधि) but as शिलामत्त्व is रक्तवर्ण we do not believe that our forefathers were successful in getting metallic arsenic.

The words अंजन and नेपाली assigned to Antimony and Arsenic are herefore totally incorrect.

The old word वंग which is usually used for Tin in the आयुर्वेदिक literature is changed to वंगक and is given to Tellurium. Every school boy knows that the suffix क does not alter the meaning of the original word. वंग and वंगक are the same. Same is the case with लोहक (Manganese) and रूपक (Nickel). Such changes which are arbitrary having no sanction of grammar and which are likely to create confusion should not be tolerated.

It would be tedious to examine all the Classes in detail; we therefore deal with some glaring instances.

दह्नातु is Potassium as "it oxidizes rapidly in air and is hence kept under kerosene or other hydrocarbon liquid." This property of Potassium is equally shared by Sodium which however is called क्षारातु. It should be noted also in this connection that दह् is a transitive verb; ज्वल is intransitive and would have been the correct root for deriving the word.

Why should Sodium be called क्षारातु ? Is it because it gives क्षार (alkali)? But that is not the property of Sodium alone. As a matter of fact all metals give on oxidation bases which differ in strength according to the nature of the metal.

यवक्षार and सज्जिकाक्षार are old and familiar names for Potassium Carbonate and Sodium Carbonate and should have been taken advantage of.

The specific gravity of Osmium is 22.48 and that of Iridium 22.4. They are गुर्वातु (गुरु heavy) and घनातु (घन dense). The difference of 0.08 in the specific gravity is too small to be used as a basis for naming elements.

Dr. Raghu Vira has discarded proper names *i.e.*, names of countries and persons, which are used to derive names for new elements. Etiquette and good sense however demand their retention. Mme. Curie during her researches on radio-active elements discovered a new element which she dedicated to her motherland and named Polonium after Poland. Should we not respect her sentiments and accept the name given by her ? There are about 24 such names (Nos. 19, 20, 24, 41, 42, 44, 46, 48, 50, 52, 53, 54, 55, 56, 57, 59, 63, 66, 74, 76, 77, 84, 86, 87 of the Dictionary) which should be retained as they are chosen by their discoverers.

(2) Scientific Matter

Dr. Raghu Vira tries to find out Indian equivalents to English units of weights and measures. "The starting point is *yava* (यव) which is no more and no less than a grain. 180 *yavas* make one *tola*. The present day Indian Government or Railway *Seer* is 80 *tolas*, one *tola* being exactly 180 grains." The statement that 180 *yavas* make one *tola* is doubtful. At the end of the consolidated series of weights and measures Dr. Raghu Vira quotes व्याख्यानसुधा of आनुजिर्दाक्षित on अमरकोश. We quote the following lines from the same authority.

पलं प्रकुंचकं मुष्टिः कुडवस्तच्चतुष्टयम् ।
चत्वारः कुडवाः प्रस्थश्चतुःप्रस्थमथ ढक्कम् ।
अष्टाढको भवेद् द्रोणो द्विद्रोणः सूर्प उच्चते ।
साधंसूर्पो भवेत्खारी द्विद्रोणो गोण्युदाहता ।
तामेव भारं जानीयाद्वाहो भारचतुष्टयम् ॥

In tabular form :

४ प्रकुंचक	=	१ कुडव
४ कुडव	=	१ प्रस्थ
४ प्रस्थ	=	१ आढक
८ आढक	=	१ द्रोण
२ द्रोण	=	१ सूर्प (गोणी, भार)
१½ सूर्प	=	१ खानी
* ४ भार	=	१ वाह

It should be noted that these are cubic measures (प्रस्थमानां त्वाह). The measures for weights are given in verses 85-87 in the same section of अमरकोश. They are

यौतवं द्रुवयं पाव्यमिति मानार्थकत्रयम् ।
 मानं तुलाङ्गुलिप्रस्थैः गुग्जाः पंचायमाषकः ॥८५॥
 ते षोडशाक्षे कर्षोऽग्नी पलं कर्षचतुष्टयम् ।
 सुवर्णविस्तौ हेम्नोऽक्षे कुरुविस्तस्तु तत्पले ॥८६॥
 तुला स्त्रियाम् पलशतम् भारः स्याद्विंशतिस्तुलाः ।
 आचितो दशभाराः स्युः शाकटो भार आचितः ॥८७॥

In tabular form :

५ गुग्जा	=	१ आयमाष
१६ आयमाष	=	१ कर्ष, अक्ष, तोला
४ कर्ष	=	१ पल
१०० पल	=	१ तुला
२० तुला	=	१ भार
१० भार	=	१ आचित — a cart load.

This does not however give us the relation of यव and तोला. We have to go to रसार्णव for that purpose.

षट् त्रुत्यश्चैकलिक्का स्यात् षट् लिक्का यूक एव च ।
 षट् यूकास्तु रजःसंज्ञाः कथितास्तव सुव्रते ॥३२॥
 षड्रजः सर्षपः साक्षात् सिद्धार्थः स च कीर्तितः ।
 षट्सिद्धार्थाश्च देवेशि यवस्त्वेकः प्रकीर्तितः ॥३३॥
 पड्यवैरेक गुग्जा स्यात् षड्गुग्जाश्चैकमाषकः ।
 माषा द्वादश तोलः स्यात् अष्टौ तोलाः पलं भवेत्
 द्वात्रिंशत्पलकं देवि शुभन्तु परिकीर्तितम् ।
 शुभस्य तु सहस्रे द्वे भार एकः परिकीर्तितः ॥३५॥
 (रसार्णवे दशमः पटलः । P. C. Ray, Ed. 1910, pp. 150, 151.)

* निर्णयसागर Ed. (1894) gives ८ खारी = १ वाह.

In tabular form :

६ त्रुटी	=	१ लिखा
६ लिखा	=	१ यूक
६ यूक	=	१ रज
६ रज	=	१ सर्षप — सिद्धार्थ
६ सिद्धार्थ	=	१ दव
६ दव	=	१ गुंजा
६ गुंजा	=	१ माषक
१२ माषक	=	१ तोला
८ तोला	=	१ पल
३२ पल	=	१ शुभ
२००० शुभ	=	१ भार

The above 4 verses of रसार्णव have been practically *ad verbatim* taken up in रसकामधेनु (—प्रथमे उपकरणपादे द्वितीयाधिकारे श्लो. ६१-६४.) It appears therefore that this system of weights was for a long time taken as standard by the Hindu Chemists. If this be so, one tola is 432 yavas and not 180 yavas as Dr. Raghu Vira takes it. Even taking it to be 180 yavas or grains and 2.5 tolas equal to one ounce, 450 grains or yavas make one ounce. But if we convert the three different ounces to grains or yavas from the data given in columns 49, 50 and 51 of pt. 3 of Vol. I, in no case we get an ounce equal to 450 grains (yavas). The results are given in the following table.

Dr. Raghu Vira's				Col.	Col.	Col.
Ounce				49	50	51
Grains	..	..	450	437.5	480	480

Such inaccuracy will never be tolerated in the scientific world. To translate English units of weights by Indian ones is unscientific and therefore futile. A yava cannot be a grain. Weights and measures are peculiarities of each country and to keep that peculiarity and distinction they should be called by their native names.

Now few stray examples of incorrect scientific information.

Col. 16 of Vol. I, pt. 1.

Aurine is supposed on philological ground to be derived from Aurum (Gold स्वर्ण) and is therefore named स्वर्णी. This aurine is also given as equal to Rosolic acid. As a matter of fact aurine is not a gold compound and is not rosolic acid. Their chemical formulae are given below :

Aurine	$C_{19}H_{14}O_3$
Rosolic Acid	$C_{20}H_{16}O_3$

Col. 17 of the same part.

Az, Azo are अज. It is a short form of French Azote (अजीवाति) for nitrogen. On this ground Azelaic acid is अजतलिक अम्ल. This acid however does not contain nitrogen, its chemical formula being $COOH(CH_2)_7COOH$. In chemistry books the name of the acid is written as azelaic acid, not as az-elaic acid as Dr. Raghu Vira writes.

The name of azo compounds which contain the peculiar grouping of Nitrogen atoms (—N : N—) are written with a dash between azo and the other part of the name, as for example :

Azo-benzene
Azo-carminc
Azo-naphthelene
Azo-phenylene

It should also be noted that the simple word अज is not sufficient to give out that peculiar grouping of nitrogen atoms.

Azo-benzene (अजधूमन्ये) is $\text{C}_6\text{H}_5\text{N : NC}_6\text{H}_5$ and
Azelaic acid (अजतैलिक अम्ल) is $\text{COOH (CH}_2)_7\text{COOH}$

in both these names (even taking the name अजतैलिक अम्ल for azelaic acid to be correct) अज does not give any idea of their chemical formulae.

The philologist has completely failed here.

Again the words like arsine, stibine, phosphine are नेपी, अंजनी and भास्वनी respectively on their similarity of ending in -ine with chlorine, bromine, iodine which are नीरजा, दुराग्री and जंबुकी.

But chlorine, bromine and iodine are elements and their molecules are di-atomic. They are represented by Cl_2 , Br_2 , I_2 respectively. Arsine, Stibine, Phosphine are however, compounds having the following formulae.

Arsine	AsH_3
Stibine	SbH_3
Phosphine	PH_3

Not the visual similarity, but the similarity of meaning should be the guiding principle in forming new words.

Col. 16 of the same part.

Arsonium is derived from *Arsenic* and *Ammonium* and is therefore named नेप तातु. Similarly

Stibonium	अंज तातु
Phosphonium	भास्व तातु

The derivation is hopelessly incorrect. Arsonium is not a compound of arsenic and ammonium ; neither is it a metal as is indicated by the ending तातु. Arsine, stibine and phosphine combine with acids and form salts similar to those of ammonium.

NH_3 ammonia	+	HCl Hydrochloric acid	=	NH_4Cl ammonium chloride
AsH_3 arsine	+	HCl	=	AsH_4Cl arsonium chloride
SbH_3 stibine	+	HCl	=	SbH_4Cl stibonium chloride
PH_3 phosphine	+	HCl	=	PH_4Cl phosphonium chloride

Arsonium and similar other words are formed only in imitation of ammonium without any indication of ammonium content therein. The end तातु of नेपतातु and other words is misleading and incorrect.

(3) Word Formation

During the course of the above discussion we have shown how a blind philologist having no regard for scientific meaning and significance commits serious blunders. A few more examples of word formations which do not require any deep knowledge of chemistry will now be given. Among the general principles of word formation, which he has followed, Dr. Raghu Vira mentions "minute analysis of the formative elements of a word" to be the important one, and describes his process as follows : "The prefix is translated by a prefix, the base or root by a base or root, the suffix by a suffix, the assemblage presenting an organic whole."

(1) Rubber Cork

Rubber दृषि

Cork त्वक्षा

Rubber Cork दृषित्वक्षा

Neither दृषि nor त्वक्षा have the significance and association of Rubber and Cork respectively. The assemblage also presents an ugly combination. The same may be said of शिखि पिषा (Stop cock). The order of the formative elements of the word i.e., शिखि and पिषा is changed.

- (2) Meter—the standard of length is मान and that word is used without exception for meter wherever it occurs. Thermometer is therefore तापमान. But meter in thermometer is different from meter—the standard of length. Here it means an instrument for measuring. Dr. Raghu Vira has no regard for invisible meaning of a word ; he looks only to the apparent and visual form of the word and thinks that a word he has created is flexible enough to give all shades of meaning. He has no need of old Sanskrit grammar which is able to give any appropriate word. Poor Panini ! he had not this hat trick ! His grammar must surely be modified to satisfy the present needs !

Barometer is भारमान !

But Dr. Raghu Vira forgets that भार is already booked for weight and that barometer is not an instrument to measure weight. It is an instrument to measure pressure. To translate baro—by भार and be satisfied is a sheer mistake.

- (3) Chlorine, though derived from Greek Chloros—pale green, is called by Dr. Raghu Vira नीरजी as "It is used as a powerful bleaching agent." Chlor or Chloro is therefore नीर—

We wonder how Dr. Raghu Vira will name chlorophyll—colouring matter of green parts of plants. We could not find that word in the parts of the Dictionary so far published.

- (4) Meta originally means "change" as in meta-genesis, metamorphosis, meta-morphic.

To Dr. Raghu Virā it is सम्. We have still to wait for the equivalents of these words ; they are under formation.

(5) Cata is नि

Hydrolysis is जलान्न, उद्गन्

Catalysis would be नि + अन्न = न्यन्न

We do not know whether न्यन्न would be the equivalent of catalysis which means "Effect produced by a substance that without undergoing change itself aids a chemical change in other bodies."

(4) *Incorrect Use of Sanskrit Words*

We have great regard for Dr. Raghu Virā's Sanskrit scholarship and philology ; still we cannot follow the relation of Ortho to उद्घ. German Kohle, English coal to Sanskrit अगार, German Wasser, English water to Sanskrit उद्.

Many of the Sanskrit words which he uses have not been used in correct Sanskrit sense also.

- (1) प्रकृति is more or less a philosophical term. To use it to "matter" of the physical sciences is to deprive it of its philosophical and metaphysical associations.
- (2) स्थान is used for volume (space) which is incorrect. It is however used in the correct sense in the following sentence

"जब तरल उबलने लगेगा तब पारा एक स्थान पर
टहर जाएगा" (रसायन प्रवेशिका पृ. १४)

- (3) तरल is "fickle," not "liquid."
- (4) सान्द्र is "dense," not "solid."
- (5) The change of temperature is translated by ताप-परिवर्तन. परिवर्तन is "change" no doubt, but in the sense of "transformation." The word is used in this correct sense in

"ताप का एकसे दुसरी श्रेणीमें परिवर्तन" (र. प्र. पृ. ५)

- (6) Experiment is प्रयोग and not संपरीक्षा
- (7) ऋजु is "upright," "straightforward," and not "normal." Normal should be स्वाभाविक.
- (8) गुंज means "collection," "heap," and cannot be used for Mass which is द्रव्यजात or वस्तुजात
- (9) अभ्याकृष्टि does not bring out all the meaning of gravitational force. गुरुत्वाकर्षण now very common in Marathi is the correct word.

- (10) The correct meaning of अपेक्षिक is "raising expectation" and not "specific." Marathi word विशिष्ट गुरुत्व is a better term.
- (11) पावन is "purification,"—not "filtration."
- (12) आसवन is "fermentation"—not "distillation."
- (13) संवाहक is used for conductor. Dr. Raghu Vira should have remembered the well-known shampooer of मृच्छकटिक and should have avoided the word.
- (14) संकेद्रण is not an happy choice for "concentration."
- (15) Spout is ओष्ठ or तुण्ड !
- (16) Dairy Thermometer is गव्य तापमान
गव्य is nearer to पच गव्य should be the word

(गव्या गोत्रा गवां अमरकोश)

We do not want to expand the list. We however cannot avoid the temptation of giving an instance of Dr. Raghu Vira's wanton way of writing Sanskrit which matches well with his wanton use of Sanskrit words.

निपीडे स्थिरे सत्य् एकैक शक्तिक-तापांशम्भ्रु

वातेः शक्तिक शून्यांश-स्थ-परिमायाः २७३ तमो भागो

वर्धते ऽहसते वा ॥ (र. प्र. पृ. ७)

None would tolerate such writing of Sanskrit.

An idea of having an English-Indian Dictionary which will satisfy the needs of all provinces of India is, as we have remarked in the beginning a grand one ; its execution will no doubt be a national asset. Still one should not forget its limitations and should not make any false claims on its behalf. Dr. S. S. Bhatnagar writes in his Foreword that "The Great English-Indian Dictionary is an instrument of education which will be of immense assistance to the spread of scientific knowledge in the country." We beg to differ from the learned Doctor. In spite of the agreed opinion of educationists all over India we do not believe that "the major obstacle in the spread of the knowledge of modern sciences in the country is the absence of appropriate terminology of technical terms." The medium of instruction, of explanation, of lucidation, facilities to have acquaintance and use of scientific instruments and machinery, and possibilities of verifying the scientific truths that are given in the text books are mainly responsible for the spread of scientific knowledge. Mere words will not help much. "Raman" and "effect" are very simple words, but Raman Effect is not so simple to grasp as the sum of these two words even though they may be expressed in Sanskrit or any provincial language of India. Even accepting these limitations, the Dictionary must be thoroughly revised both in Planning and Terminology before it can attain the claim which it now assumes.

DR. JOHNSON AND INDIA

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ENGLISH writers from the time of Alfred to the present day have displayed an abiding interest in India and the East, either through casual allusions and oriental imagery employed by them, or, even more explicitly, by their use of Indian or Oriental themes, characters and background. Though Dr. Johnson's works do not abound in such allusions or themes, his name must be added to the list of those great Englishmen who felt the lure of the East, especially of India.

The legend that Johnson was a Londoner who thought London was the only place worth living in has grown up partly because of some of Johnson's sayings and partly because of Macaulay's famous exaggeration.¹ True, Dr. Johnson's talk abounded in such sayings as: "A man who is tired of London is tired of life" and "The full tide of human existence is in Charing Cross." But few Englishmen have had Johnson's curiosity which made him visit various localities; few have had the Doctor's intellectual thirst for knowledge about peoples and places. As Dr. Birkbeck Hill² says, "Johnson had no contempt for foreign travel." He had all the qualities that go to make one an eager traveller—"curiosity, hardihood, courage and patience" beyond any other man of letters of his time.³ When his thoughts turned to the world outside England his curiosity and his passion for knowledge were aroused. But his actual travels were limited in his early years by want of money and, after the pension, by his physical weakness. Johnson was ready to travel when his health permitted and when he had travelling companions whose spirit of inquiry and enterprise equalled his. Dr. Hill's impressive list of Dr. Johnson's absences from London and visits to various places such as Oxford (1755 and later), Harwich (1763), Streatham (1765), "the Western islands of Scotland" (1773), Wales (1774) and France (1775) shows that Dr. Johnson travelled more frequently than is imagined. In his *Journey to the Western Islands* Dr. Johnson wrote: "All travel has its advantages. If the passenger visits better countries, he may learn to improve his own, and if fortune carries him to worse, he may learn to enjoy it."⁴ Obviously it was love of travel and also love of knowledge which caused Johnson to visit places outside London so frequently.

Dr. Johnson's curiosity about India was unbounded. In his letter to Warren Hastings,⁵ written on 30th March, 1774, Dr. Johnson said :

¹ Macaulay's *Literary Essays*, 1923, page 245. "Of foreign travel and of history he spoke with the fierce and boisterous contempt of ignorance."

² Boswell's *Life of Johnson*, edited by Hill-Powell, Vol. 3, page 450.

³ Roscoe : *Aspects of Dr. Johnson*, page 120.

⁴ Johnson's *Journey to the Western Islands*, 1924, page 35.

⁵ Boswell's *Life of Johnson*, Hill-Powell, Vol. 4, pages 68 to 69.

"I have no question to ask ; not that I want curiosity after either the ancient or present state of regions, in which have been seen all the power and splendour of wide-extended empire ; and which as by some grant of natural superiority, supply the rest of the world with almost all that pride desires and luxury enjoys. But my knowledge of them is too scanty to furnish me with proper topics of enquiry; I can only wish for information ; and hope, that a mind comprehensive like yours will find leisure, amidst the cares of your important station, to enquire into many subjects of which the European world either thinks not at all, or thinks with deficient intelligence and uncertain conjecture. I shall hope, that he who once intended to increase the learning of his country by the introduction of the Persian language, will examine nicely the traditions and histories of the East ; that he will survey the wonders of its ancient edifices, and trace the vestiges of its ruined cities ; and that at his return, we shall know the arts and opinions of a race of men, from whom very little has been hitherto derived.

.....There are arts of manufacture practised in the countries in which you preside, which are yet very imperfectly known here, either to artificers or philosophers. Of the natural productions, animate and inanimate, we yet have so little intelligence, that our books are filled, I fear, with conjectures about things which an Indian peasant knows by his senses.

Many of those things my first wish is to see ; my second to know by such accounts as a man like you will be able to give...."

Johnson's friendship with Hastings, which was to last through all the vicissitudes of Hastings' life and of which this letter is an initial record, was established in the year 1766 when Hastings had returned to London after service in India for some years. The friendship was "founded on their mutual interest in the Persian language, an interest which gave Hastings the idea of establishing a chair for Persian at Oxford to promote its study in England."⁶ The India Office Records of 1801 report Hastings' statement to the Directors: "The late Dr. Johnson promised if it took place (the establishment of the Chair) to frame a code of regulations for the conduct of it."⁷

To an Indian student of English Literature it is exciting to know that Johnson contemplated a journey to India as early as 1756 in the company of the famous East Indian merchant-adventurer and civil servant Joseph Fowke. The story may be told in Johnson's words as reported by Boswell:—"Friday 5, April 1776. 'I lately received a letter from the East Indies, from a gentleman whom I formerly knew very well ; he had returned from the country with a handsome fortune, and lost all he had He resolved to go out again to the East-Indies; and make his fortune anew. He got a considerable appointment and I had some intention of accompanying him. Had I thought then as I do now, I should have gone ; but at that time I had objections to quitting England."⁸

⁶ *Warren Hastings* by A. M. Davies, London, 1935, page 60.

⁷ *Warren Hastings* by A. M. Davies, London, 1935, page 546.

⁸ *Life*, edited by Hill-Powell, Vol. 3, page 20.

This friend with whom Johnson proposed to migrate to India was Joseph Fowke who first came to India in 1736 as a "writer" and remained here filling various offices till 1752 when he resigned his post of the Councillor of Fort St. George, Madras and returned to England with a modest fortune. He squandered it soon; it was then that Joseph Fowke became acquainted with Johnson and, as Powell conjectures, it may have been in 1756 that Fowke was contemplating return to India on securing "a considerable appointment" there.

But it is difficult to date precisely this proposed migration of Johnson to India. The following additional passage from Boswell's *Journal*, suppressed from the *Life*, shows that it must have been after the *Dictionary* was completed (1754).

"Boswell: 'I am glad you did not go. We should not have had the *Dictionary*.'⁹ Johnson: 'Yes. You would. This was about the year 1746'." The mention of 1746 is an error as the *Dictionary* was published in 1754 only. Boswell made a note in his *Journal* that the date '1746' given by Johnson was wrong, and he must "get more from him (Johnson) about this oriental scheme." Johnson's mother was alive in 1756 and it may have been his affection for her that detained him in England. Fowke himself appears to have declined the appointment for it was not till 1770 that he was permitted to return to India.

So ended the proposed migration of Johnson to India. How one wishes it had taken place and Johnson had stayed in India for some time to give us, perhaps, a *Journey to the East Indies*! To Johnson, India and the East Indies were identical and he meant India when he used the expression, 'East Indies.' It is doubtful, however, whether Johnson would have enjoyed a voyage to India. As Sir John Fortescue observes,¹⁰ "Voyages to distant lands, such as to India round the Cape of Good Hope, were a more serious matter, though the East India Company's ships were famous for excellence. The passage rarely took less than six months and, if anything went wrong, might be prolonged for two or three months more. Robert Clive was nine months at sea when he first sailed to India as a youth and had outgrown all of his clothes before he reached Calcutta." Johnson's dislike of the sea was intense. He told Boswell:¹¹ "A ship is worse than a jail. There is, in a jail, better air, better company, better conveniency of every kind; and a ship has the additional disadvantage of being in danger."

But India seems to have continued to fascinate Dr. Johnson, for, whenever favourable circumstances arose, a visit to India crossed Johnson's mind as one of the adventures he might undertake. In 1775 the Thrales had just received a sum of £14,000. Then Dr. Johnson wrote thus to Mrs. Thrale:

"If I had money enough, what would I do? Perhaps, if you and master did not hold me, I might go to Cairo, and down the Red Sea to Bengal, and take a ramble in India. Would this be better than building

⁹ *Life*, edited by Hill-Powell, Vol. 3, page 471.

¹⁰ Turberville: *Johnson's England*, Vol. I, page 77.

¹¹ *Life*, edited by Hill-Powell, Vol. 2, page 438.

and planting? It would surely give more variety to the eye, and more amplitude to the mind."¹²

"According to Mr. Tyers he once offered to attend another friend to India."¹³

The reason which prompted Johnson to think of migrating to India in 1756 will remain hidden in the region of speculation and conjecture. But it is necessary to suggest that Johnson would not have thought of this step as a means of amassing wealth. According to Boswell's *Life of Johnson*, Johnson dined at Mr. Strahan's on Sunday, October 10, 1779 and "the conversation turned on the prevailing practice of going to the East Indies in quest of wealth." Johnson: "A man had better have ten thousand pounds at the end of ten years passed in England, than twenty thousand pounds at the end of ten years passed in India, because you must compute what you *give* for money; and a man who has lived ten years in India, has given up ten years of social comfort and all those advantages which arise from living in England." Perhaps it was search of honest employment (and not mere wealth) combined with intellectual curiosity that made Johnson think of migrating to India, for it must be remembered that even in 1756, before the pension was granted, but, after the *Dictionary* had been published, Johnson was never above want.

Johnson's interest in India continued unabated, for some of his friends migrated to India, accepting various appointments under the East India Company. Warren Hastings, Sir William Jones, Sir Robert Chambers and Mr. Joseph Fowke were some of these friends of Johnson in India. Sir William Jones was elected member of the Literary Club in 1773 and he was described at the time of his election at the Club as "the elegant author of the '*Persian Grammar*'."¹⁴ In the imaginary College which Johnson's Club should set up in St. Andrews, Jones was to be the Professor of Oriental Learning and Chambers¹⁵ the Professor of the Laws of England. Sir William Jones had a distinguished career in India as a Judge from 1783 to 1794, the year of his death. In 1771 Jones who was then in England published his "*Grammar of the Persian Language*" and a copy of this book was sent by Dr. Johnson to Hastings in India with a letter sent through Robert Chambers in March 1774. (See *supra*).

A new era was opening in the relations between England and India. A new type of Englishmen was now sent by the Company as its chief servants in India. Scholars and gentlemen such as Hastings, Chambers, Sir William Jones and Wilkins who came out to India as Civil servants became the ambassadors of India's literature and religion in England. In effecting this closer bond between the two countries it is pleasant to think that Dr. Johnson rendered some service, for he was the president,

¹² B. Hill. *Letters of Samuel Johnson*. Letter No. 692.

¹³ *Life*, edited by Hill-Powell, Vol. 3, page 458.

¹⁴ Quoted by R. M. Hewitt in '*Harmonious Jones*,' *Essays and Studies*, Vol. 28 for 1942, page 47.

¹⁵ Chambers is the subject of an article by the author in *The Modern Language Review* for 1948.

as it were, of this band of scholars. The enthusiasm of this literary group for oriental religion and scholarship and languages may be regarded as an early seed of Romanticism sown in the field of English literature in the eighteenth century.

The three letters Johnson wrote to Warren Hastings in India are given by Boswell in his *Life of Johnson*¹⁶ and form a record of a long and happy friendship between a distinguished man of letters and a distinguished administrator. Johnson was charmed by Hastings and spoke of him with great warmth. Johnson's first letter to Hastings was written on March 30, 1774, to introduce to Hastings Robert Chambers, a member of the Club and the Vinerian Professor of Law at Oxford, who came to India in 1774 as a Judge of the Supreme Court at Calcutta. With this letter a copy of Jones' *Persian Grammar* was sent to Hastings by Johnson. The second letter was written by Johnson on 20th December 1774 and therein Johnson recommended to Hastings' patronage the son of his friend Dr. Lawrence, one Chauncey Lawrence, who was employed in the Company's service in India. Johnson's third letter of March, 1781 was written to Hastings to solicit his patronage for a translation of Ariosto, that was then undertaken by Johnson's friend, "Auditor" Hoole, then a clerk of the East India House and "its literary light." Hastings himself was essentially a man of letters rather than a man of action. How highly Johnson valued Hastings' friendship is shown by Johnson's refusal to prepare Joseph Fowke's narrative for the press.¹⁷ When the latter, who was then in India and opposed Warren Hastings in the trial of Nanda Kumar, sent his papers to Johnson in 1776, Johnson refused to help his friend Fowke as he lived "in a reciprocation of civilities" with Warren Hastings.¹⁸ Hastings cherished Johnson's friendship equally and placed the three letters he received from Johnson at the disposal of Boswell for publication in the *Life*. These three letters, as Boswell says, "form a grand group in the biographical picture" of Johnson.

Johnson's opinions on the Government of India are bound to raise a laugh now ; but it should be remembered that corruption was then widespread even among the highest of the Company's servants in India and that Johnson himself was an advocate of political subordination of the people to the ruler. The following opinion that Johnson expressed on the Government of India must have been the result of these views of his. Perhaps Johnson's personal feeling towards Hastings, his friend, also made Johnson anxious to support Hastings' measures. The following opinions of Johnson were expressed in the course of a conversation about the accusations against Hastings.

"Monday, April 28, 1783. . . . We talked of the accusation against a gentleman for supposed delinquencies in India. Johnson: 'What foundation there is for accusation I know not, but they will not get at him. Where bad actions are committed at so great a distance, a delinquent can obscure the evidence till the scent becomes cold ; there is a cloud between, which cannot be penetrated ; therefore all distant power is bad. I am

¹⁶ Boswell's *Life of Johnson* : Hill-Powell, Vol. IV, pages 68 to 71.

¹⁷ Boswell's *Life of Johnson* : Hill-Powell, Vol. III, pages 20 to 22.

¹⁸ B. Hill : *Letters of Johnson*. No. 495.

clear that the best plan for the Government of India is a despotic government ; for if he be a good man, it is evidently the best government ; and supposing him to be a bad man, it is better to have one plunderer than many. A governor whose power is checked, lets others plunder, that he himself may be allowed to plunder ; but if he be despotic, he sees that the more he lets others plunder, the less there will be for himself, so he restrains them ; and though he himself plunders, the country is a gainer, compared with being plundered by numbers'."¹⁹

The advocacy of benevolent despotism as a method of governing subject nations is out of date; but it must be remembered that in Johnson's days, the East Indian *Nabobs* who flocked to London flaunting their wealth had given rise to ugly reports about the conduct of the Company's servants in India and there was an intense agitation for the reform of the terms of the Charter granted to the Company. Very little about India was known to the Englishmen of those days and Johnson's sympathy for the Indians is evident in his desire to save them from becoming victims of large scale plundering by unscrupulous adventurers from the West. Indeed Dr. Johnson anticipated the argument of Burke about civil servants in India and realised that the amount of power put into the hands of officers beyond the reach of criticism was dangerous.²⁰ The ostentation of the 'Nabobs' had roused the disgust of Englishmen and Johnson's opinion was the opinion of the intelligent Englishmen of his time about India.

Johnson's views on the caste system in India are based on imperfect acquaintance with the problem. On Saturday April 7, 1781, Johnson and Boswell dined at Mr. Hoole's, with Governor Bouchier (Governor of Madras from 1767 to 1770) and Captain Orme, both of whom had been long in the East Indies. In these Indian surroundings, the subject of caste was discussed.

"Johnson defended the oriental regulation of different *castes* men, which was objected to as totally destructive of the hopes of rising in society by personal merit. He showed that there was a *principle* in it sufficiently plausible by analogy. "We see (said he) in metals that there are different species ; and so likewise in animals, though one species may not differ very widely from another, as in the species of dogs—the cur, the spaniel, the mastiff. The Bramins are the mastiffs of mankind."²¹

On another occasion, when Johnson dined at Mr. Thomas Davies's (April 6, 1775), the question arose "whether the judges who went to India might with propriety engage in trade." Johnson warmly maintained that they might.²²

"For why, (he urged) should not judges get riches, as well as those who deserve them less?" I (Boswell) said, they should have sufficient salaries and have nothing to take off their attention from the affairs of the public.

¹⁹ Boswell's *Life of Johnson* : Hill-Powell, Vol. 4, page 213.

²⁰ Robert Sencourt : *India and English Literature*, page 206.

²¹ Boswell's *Life of Johnson*, Hill-Powell, Vol. 4, page 88.

²² Boswell's *Life of Johnson*, Hill-Powell, Vol. 2, page 343.

Johnson: "No judge, Sir, can give his whole attention to his office; and it is very proper that he should employ what time he has to himself, for his own advantage, in the most profitable manner." "Then, Sir, (said Davies), he may become an insurer; and when he is going to the bench, he may be stopped,—'Your Lordship cannot go yet : here is a bunch of invoices : several ships are about to sail'." Johnson: "Sir, you may as well say a Judge should not have a house ; for they may come and tell him, 'Your Lordship's house is on fire ;' and so, instead of minding the business of his Court, he is to be occupied in getting the engine with the greatest speed. There is no end of this. Every Judge who has land, trades to a certain extent in cattle; and in the land itself, undoubtedly. A Judge may be a farmer; but he is not to geld his own pigs. . . . No, Sir; there is no profession to which a man gives a very great proportion of his time. It is wonderful, when a calculation is made, how little the mind is actually employed in the discharge of any profession. No man would be a Judge, upon the condition of being obliged to be totally a Judge. The best employed lawyer has his mind at work, but for a small portion of his time : a great deal of his occupation is purely mechanical."²³

Johnson's views upon Judges' right to private employment are based on sound commonsense and have been the accepted basis of legal administration in India.

As the years advanced Johnson's intellectual curiosity about India lost its original vigour. In the last year of Johnson's life Burke sent Johnson his speech upon the affairs of India, a volume of above a hundred pages closely printed. Writing to Dr. Taylor on this on 24th January, 1784, Johnson said :

"I will look into it ; but my thoughts now seldom travel to great distances."²⁴

Such was the origin, growth and decline of Johnson's interest in India, an interest characterised by the masculine commonsense, love of justice and sympathy for the oppressed, that were some of the essential features of the Doctor's character.

²³ Boswell's *Life of Johnson*, Hill-Powell, Vol. 2, page 343.

²⁴ Johnson's *Letters*, (ed. by Hill) Letter No. 928. Quoted by Hill in his edition of Boswell's *Life of Johnson*, Vol. 4, page 260.

THE DOCTRINE OF AHIMSA IN THE JAINA CANON

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[Continued from p. 96 of Vol. XVI, Part 2 (Arts No. 22)]

CHAPTER IX

QUEER NOTIONS ABOUT AHIMSA AND HIMSA

[*Ārdraka and the opponents of Mahāvīra, Hastitāpasa-vāda, Saṃsāra-mocaka-mata, and misapprehensions about ahimsa.*]

CHIMANLAL Amulakh Sanghavi in his article “आर्द्रकुमार-नेबुचदनेझार” published in “Mahavira Jaina Vidyalaya Commemoration Volume” says:—

(1) Ārdrakumāra was the son of Nebuchadnezzar who became the emperor of Babylon in 604 B.C. and was the grandson of Nabopolshar. (2) Nebuchadnezzar got rebuilt the temple of Nemirātha as could be inferred from a copper-plate of Prabhāsnāṭaṇa deciphered by Dr. Prannath. (3) Ārdranagara is same as the port Erdiu. Without confirming or criticizing these views I proceed to note the discussions Ārdrakumāra had with some of the opponents of Lord Mahāvīra.

Ārdraka and the opponents of Mahāvīra.—From the *Nijjutti* (v. 190 and 198) of *Sūyagada* (II, VI) we learn that Ajja Addaā (Ārya Ārdraka) comes across (i) Gosāla, (ii) a *bhikkhu* (a *Bauddha* monk), (iii) Bambhavañ, (iv) Tidaṇḍi and (v) Hatthitāvasas (Hastitāpasas) who find fault with the views of Mahāvīra, and that this Addaā refutes the arguments advanced by them. Of these we are here concerned with the following :—

(1) Bauddha-Ārdraka-vāda, (2) Ekadaṇḍin and (3) Hastitāpasa—Ārdraka-vāda popularly known as ‘Hastitāpasa-vāda’.

We shall begin with the last.

Hastitāpasa-vāda—This *vāda* is briefly noted in *Schools and Sects in Jaina Literature* (p. 39). The *Hastitāpasas* along with the *Saṃsāra-mocakas* and others are mentioned in *Upamitibhava-prapañcākaṭṭhā* (IV, v. 287; p. 365a) whereas those with the *Ambubhakkhis* and others in *Pupphiyā* (p. 40, P. L. Vaidya’s edn.). In *Sūyagada* (II, 6, 52-54) there is a reference to a person who maintains himself by killing one elephant every year by means of one arrow as he wishes to be kind to the remaining living beings. The author of *Sūyagada* suggests :—

(1) This action of yours is faulty, (2) There is a very little difference between you and house-holders who kill one living being, and (3) a person of your type who does harm to his soul, cannot become omniscient.

In v. 190 of *Sūyagaḍa nijjuttī* there is a mention of *Haṭṭhitāvasas* and in v. 198 that of *Tāvasas*. But there are no arguments advanced to refute the view of these *Tāvasas*. So for this, we have to refer to *Śīlāṅka Sūri's* com. (p. 101a on this *āgama*). He says :

When Ādrakumāra was on his way to Mahāvīra after refuting the arguments of *Ekadandīn*, the *Haṭṭitāpasas* surrounded him. By 'Haṭṭitāpasas' are meant those *Tāpasas* who maintain themselves by killing an elephant. The oldest among them said to Ādrakumāra as under :—

One who is well-versed in *śruti* should always think of *alpabahuṭva*. Those *Tāpasas* who eat bulbuous roots, roots and fruits are engaged in killing many *sthāvara* (immobile) beings and the *jaṅgama* (mobile) ones which resort to *udumbara*, etc. Even those who live upon begging are polluted on account of the *āśaṃsā-doṣa*. While wandering here and there they kill insects such as ants, etc. But we kill one big elephant by means of an arrow at the end of even a year and so not necessarily at the end of every six months as we are kind towards other living beings, and we maintain ourselves for a year by his flesh. Thus we protect many living beings by killing few.

Ādrakumāra replies : those who kill one living being every year are not free from the fault of *hiṃsā*. The *āśaṃsā-doṣa* is very wicked in the case of you who are engaged in killing a big living being having five sense-organs. But the saints who go on roads illuminated by the rays of the sun, by looking ahead to the distance of a yoke, who are careful in walking, who search for food free from forty-two faults¹⁰³ and who are indifferent to acquisition and non-acquisition (of alms) are free both from *āśaṃsā-doṣa* and the killing of living beings like ants. You believe that there is absence of fault in killing few living beings. If so, even house-holders kill only those living beings who are in a place within the range of their *āraṃbha*, and they are not engaged, according to you, in killing the remaining living beings who are not there and then. Consequently, as these house-holders kill few, they, too, are faultless.

On having refuted the *Haṭṭitāpasas*, Ādrakumāra finds fault with one who preaches this doctrine. He says : Even those who having resorted to the vows of ascetics, kill one living being every year and who advise others to do so are *anāryas* (barbarians), and such persons cannot become omniscient. For they are engaged in a bad deed. They are harmful to themselves and others. They do not see that not only the *sthāvara* and *jaṅgama* living beings that resort to flesh, are killed but even others that are associated with the act of preparing flesh for meals. They have not realised a sinless way of

103 For their enumeration see *Dasaveyāliya* (V).

maintenance namely, the *mādhukarī-vṛtti*.¹⁰⁴ Hence they are not only non-omniscient but are wanting in a special type of discrimination.

Saṃsāra-mocaka-mata—In *Sūyagaḍacunṇi* (p. 157, last line and p. 158) the *Saṃsāra-mocakas* are referred to as under :—

“तीव्राध्यवसायाः तीव्रमिथ्यादर्शनिनश्च तीव्रमिथ्याध्यवसिताः संसारमोचका
याज्ञिकादयश्च”

This means : they are of excessively firm attitude, exceedingly mis-directed in faith and holding very wrong notions. On p. 163 of this *Cunṇi*, there is mere mention of the “*Saṃsāra-mocakas*” along with the “*Yājñikas*”, who are alluded to on p. 158 (1st line). The phrase “*Saṃsāra-mocaka*” occurs on p. 432, too. Haribhadra refers to “*Saṃsāra-mocaka*” in his com. on Umāsvāti’s *Sāvayapaṇṇatti* (v. 133). In his *Śāstravārtāsamuccaya* (v. 150-156, p. 22) he deals with the view of these *Saṃsāra-mocakas*, and Hemacandra does so in three verses in his com. (p. 70a) on his own work *Yogaśāstra*. There is mention of ‘*Saṃsāra-mocaka*’ in *Syādvādaratnākara* (Vol. I, p. 103). Jayanta in his *Nyāyamañjarī* (pp. 265-6, Vijayanagar edn.) says: The *Saṃsāra-mocakas* are sinners, are engaged in killing living beings and are engrossed in infatuation. Their scripture is no authority... On touching a *Saṃsāra-mocaka*, the sisters take bath without clothes on. For quotations see *Premī-abhinandana-grantha* (pp. 437-8).

In the first verse of the *Therāvali* of *Nandī* there occurs the phrase “jagabandhu.” There are three commentaries on this *āgama* : (1) Jinadāsa Gaṇi’s *Cunṇi* composed in Śaka *Samvat* 598 i.e., Vikrama *Samvat* 733, (2) Haribhadra Sūri’s *vṛtti* and (3) Malayagiri Sūri’s *vṛtti*. Of these it is the last which expounds *Saṃsāra-mocaka-mata* on pp.13a-15a. So I shall give here a summary from this Malayagiri’s *vṛtti* (pp.13a-15a). The *Saṃsāra-mocakas* say :

One should employ towards others a means of which the end is good enough, though, in the beginning it may not be pleasant e.g. administering bitter medicine which removes a disease. Unhappy living beings such as worms, moths, mosquitoes, quails, sparrows, the leper, the very poor persons, the blind, and the lame are immersed in the ocean of mundane existence as their sinful *karmans* are in operation. So they should be killed by the obliging persons as that would lead to the destruction of their sins. In killing them there arises excessive pain. Being afflicted by this pain they prematurely bring into operation their sinful *karmans* and eradicate them by realising them.

The *Jainas* argue : why should we believe that the affliction of pain leads to the result pointed out by you ? Can it not be that they amalgamate more sins as they entertain *ārta* and *raudra dhyanas* (meditations) ?

¹⁰⁴ Just as the bee sucks honey in the flowers of a tree it does not wither the flowers and nourishes itself at the same time, so the *Jaina* Clergy in the world, who are free from attachment, are intent on seeking offered food from the householders like the bees (which are intent on seekings honey) from the flowers. This act of theirs is called ‘*mādhukarī-vṛtti*.’ See *Dasaveyāliya* (I).

S. M.¹⁰⁵—No, your own scriptures uphold our view.

Jainas—How ?

S.M.—According to you, denizens of hells destroy their *karmans* amalgamated previously and do not amalgamate any more sinful *karmans*; for, on their death they cannot be reborn in any hell as they are incapable of amalgamating the *āyuh-karman* pertaining to a hell, when they are constantly beaten, pierced, cut, impaled, etc. by *Paramādhār-mika Asuras* and even when they entertain evil *dhyānas* while experiencing excessive pain caused mutually in the absence of these *Asuras*.

It is because these denizens of hells do entertain evil *dhyānas* that they destroy evil *karmans* amalgamated previously, as they resort to excessive *saṅkleśa*.¹⁰⁶ If this *saṅkleśa* is not there, even the *Paramādhār-mikas* cannot cause the *karmans* to be destroyed. So the killers, even though they lead to evil *dhyānas*, oblige those who are being killed. Consequently those who are indifferent or prohibit their killing which is going to oblige them, are great sinners. We do not say that those who experience happiness on account of good *karmans* amalgamated previously should be killed. For that would be doing harm to them as they thereby get debarred from experiencing happiness. Those who are devoted to the welfare of others never resort to *saṃrambha* as it causes harm to them.

Jainas—Your arguments are baseless. The wise should render that obligation which does good to oneself. We do not see what good you do to yourself, when you kill others. Is it that you acquire merit or is it that your *karmans* get destroyed? You cannot say that you acquire merit, since it acts as an obstacle to others. For, if they were not killed by you they would have killed others and acquired merit. Thus your killing them prevents them from acquiring merit. Further, one who acts as an obstacle to the acquisition of merit by others, does not acquire merit, as it is a contradiction, and as it gives scope to all to acquire merit. Consequently what you said in the beginning viz., “killing of the unhappy is good in the end” is unproved; for causing an obstacle in the acquisition of merit is not a happy end. If you now say that killing of others leads to the destruction of your *karman* we would like to know whether that *karman* is with or without a cause. If it is of the first type, what is the cause? Is it ignorance, *ahiṃsā* or *hiṃsā*? It cannot be ignorance; for, then, there is no possibility of refraining from *hiṃsā*. It is an established fact that a fault is removed by resorting to the contradictory of its cause. For instance, cold created by snow can be removed by resorting to fire which is contradictory—antagonistic to snow. Here *hiṃsā* is not the counteracting force of ignorance, but it is the correct knowledge that is so. So, how can *karman* produced from ignorance be destroyed by *hiṃsā*?

If you were to say that the *karman* is caused by *ahiṃsā*, it would not do; for, in that case even the liberated will have *karmans* as they are *ahiṃsāka*.

¹⁰⁵ This stands for ‘Samsāra-mocakas.’

¹⁰⁶ In Muncandra Sūri’s com. (p. 28b) on *Dharmabindu* ‘saṅkleśa’ is explained as *rāga-dveṣa-pariṇāma*.

If you say that *karman* is caused by *himsā* how can it be destroyed by *himsā* itself? One cannot be destroyed by that very object by which it is produced. A disease caused by indigestion cannot be cured by frequently resorting to indigestion. Consequently *ahimsā* must be surely practised for destroying the *karman* produced by killing living beings. This very idea is expressed in the following verse :—

“तम्हा पाणिवहोवज्जियस्म कम्मस्म खवणहेउओ ।

वद्विरई कायव्वा मंवरुव त्ति निवमेण ॥”

If the *karman* is without any cause, it does not exist like the horns of an ass. So why should you take the trouble of killing a living being to destroy the *karman*? If you say that the *karman* does exist in spite of it being causeless as is the case with *ākāśa*, the *karman* like *ākāśa* cannot be destroyed. So it is needless to kill a living being.

Further, your view that those who experience happiness on account of the good *karman*s amalgamated previously should not be killed, is unjustifiable according to your doctrine. For, salvation is attained on the destruction of merit and demerit. So, just as you exert yourself to kill others with a view to destroying their sins, so should you do for destroying their merits.

S. M.—The fruit of sin is to experience unhappiness. Hence by killing others pain is caused to them, and, consequently it leads to the destruction of their sins. But the fruit of merit is to experience happiness. So, by causing pain how can merit be destroyed? That *karman* of which the fruit is to experience happiness, can be destroyed only on creating the experience of happiness and not in other way.

Jainas.—This stand of yours is not correct. For, that special merit which is to be experienced as a celestial being, is brought nearer by causing an end to the human life. And the merit which is thus brought nearer becomes mostly such as can be experienced in a short period. Consequently, when there is thus a scope for destroying merit, how can there not be the destruction of merit on killing others?

S. M.—The realisation of merit which is to be experienced as a god on being killed, is doubtful ; for, some may have to realise demerit. So it is not proper to kill one who is experiencing merit.

Jainas.—There is scope for doubt elsewhere, too. If you kill an individual who is unhappy as described by you, that individual may have to experience pain as a denizen of hell. But, if he is not killed, he may perhaps kill many living beings, and, thus he may amalgamate merit and may be born as a god. So it is not proper for you to kill even the unhappy. Thus your *hetu* is both “sandigdha” and “anaikāntika,” as there is no guarantee about the result of killing being a good end.

Further, your reference to the nature of infernal beings, shows your ignorance of our scriptures. The real nature infernal beings is that they get nonplussed on account of their experiencing excessive pain,

when they are harassed by Parāmādhārmika gods or by other hellish beings ; but, in their case there is no excessive *saṅkleśa* elsewhere, as is noticed in this world in the case of some human beings who get confounded. When the head etc. of persons get broken by the strokes of sticks etc., they lose their consciousness on account of the excessive pain they suffer, but, there is no room for excessive *saṅkleśa* elsewhere. Same is always the case with infernal beings. Consequently these beings do not amalgamate any more new bad *karmans* as there is absence of such a type of *saṅkleśa* in them.

S. M.—If so, this *sammoha* is beneficial. For, owing to it there is no excessive *saṅkleśa* elsewhere, and the evil *karmans* amalgamated previously get destroyed on account of their suffering severe pain. This *sammoha* is caused by cruel acts. So it establishes our doctrine that those who kill others, are highly obliging.

Jainas—Certainly not. For, there is room for *kliṣṭa karmans* being amalgamated in the case of the *himsakas*, when others are harassed by them (*himsakas*). There is no other cause for sin except causing pain to others.

S. M.—There is another cause.

Jainas—If so, even the liberated will be sinners as they are *ahimsaka*. So how can thoughtful persons even think of killing others?

Misapprehensions—In *Puruṣārthasiddhyupāya* (v. 79-90) the following common misapprehensions¹⁰⁷ regarding *himsā* are mentioned :—

(1) One can commit *himsā* (a) for the sake of religion, (b) for pleasing gods and (c) for respectable guests.

(2) One can kill a life with higher vitalities in preference to a life with lower vitalities.

(3) One can kill those that kill others with the idea that the destruction of one leads to the protection of others and on the ground that the killed are thereby prevented from committing *himsā*.

(4) One may kill one in distress with the hope of relieving one from suffering.

(5) One should kill a happy person on the understanding that happiness is rarely attained, and that a person continues to remain happy, if killed, when he is happy.

(6) One should kill one's preceptor under the impression that thereby the latter will be in deep concentration of mind and will thus attain eternal bliss.

(7) One should kill a living being as it makes the soul of the killed free from its imprisonment in the body.

(8) One may kill oneself to offer flesh to one who is starving.

¹⁰⁷ Vācaka Umāsvāti in his *Sāvayapannatti* (v. 192-252) deals with several notions about *himsā*.

CHAPTER X

ALLEGATIONS AGAINST THE JAINA PRINCIPLE OF AHIMSA
AND THEIR REFUTATIONS

[*Misrepresentations and misapplications, pasture-ground for lice, saving a frog at the cost of a man, only 'kāya-daṇḍa' in Jainism and six allegations against the Jainī ahimsā.*]

Misrepresentation and misapplication—In this world in every age we do come across at least some persons who take delight in twisting the real implication of even a grand principle and turning it into an object of ridicule. Similarly, there are some who misunderstand such a principle and apply it in a wrong direction and provide a weapon to a fastidious and unsympathetic critic. So far as the principle of *ahimsā* is concerned, I know of two such cases. One of them is well depicted by Dr. Charlotte Krause in *The Heritage of the Last Arhat* (p. 13). The pertinent passage is :

“Now I have been asked several times whether it is true that the Jainas, as alleged, carry the virtue of charity so far as to cause, now and then, some poor wretch, (whom they pay off) to yield his body as a pasture-ground for lice and fleas and other amiable creatures and let them have their fill. According to my firm conviction, this horrible allegation must be a bold invention. And if it is perhaps, against all probability true that some ill-informed fanatic did such a thing, then he would have acted in straight opposition to the tenets of Jainism : for to make a being so highly developed as a human soul, suffer in such a degrading way, in the name of the humanest of all religions, would clearly fall under the heading of *Himsā*, of worst and meanest injury, and would, besides, mean a downright insult to Religion in general.”

The other case deals with the proverbial allegation *viz.*, the *Jainas* protect small living beings and destroy the big ones. A fantastic example that has reached my ears is :

Once upon a time someone yawned and curiously enough a frog entered his mouth and descended to his belly. As it could not come out it began to jump to and fro. Some persons who were nearby were over-anxious to save the life of this frog. So they suggested that the belly of the person concerned should be cut open so that the frog might come out and its life might be thus saved. They did not take into account what would happen to the man in question. One person came forward and cut the belly and rescued the frog but it led to the demise of the man concerned.¹⁰⁸

¹⁰⁸ In *Vanarāja Cāvaḍo* (p. 138, 10th edn.; 1920 A.D.) by Mahipatram Rupram it is said :

An old man was sleeping with his mouth open at the time a *Jaina* saint was delivering a sermon to the audience. Vanarāja suddenly came there and placed a small frog in his mouth. This awoke the old man.

This story, probably of a greater length in the first edn., is the root of this allegation.

There is no positive proof for this story, and even if there were one, it is nothing but sheer ignorance of the principle of *ahimsā* which, though simple, is extremely subtle.¹⁰⁹

Pandit Suklal in his Hindi introduction (p. 33) to *Jñānabindu* says : The *Jaina* view about *ahimsā* is wrongly denounced in the *Upālisutta* of *Majjhim-nikāya*. On going through this portion I find that the *Bauddhas* allege that the *Jainas* admit only *kāya-daṇḍa* and deny the other two *daṇḍas* viz. *vacā-daṇḍa* and *mano-daṇḍa*. This allegation has no basis ; for, the *Jainas* mention all the three *daṇḍas*. Ordinarily speaking, physical activity plays a prominent part in committing sins, and the *Jainas* do accept this view. But this does not debar them from assessing the value of other activities. Consider the case of a *tandula-matsya* who, owing to its very wicked thought of committing *himsā*, goes to the seventh hell. Further, in the case of *Śāmba* and *Pradyumna* the mental activity of one was rewarded and not the physical activity of the other who proceeded to bow to Lord Nemi. These are some of the instances from the *Jaina* literature, which prove the non-validity of the *Bauddha* allegation.¹¹⁰

In the end I may say that in *The Jaina Religion and Literature* (Vol. II, ch. xix) I have refuted the following six allegations :—

- (i) *Ahimsā* has emasculated the Indians and has been the cause of their cowardice.
- (ii) *Ahimsā* has led to our political downfall.
- (iii) *Ahimsā* has been carried to the extreme, i.e., has been driven to its highest logical conclusion undeterred by the practicalities of the world.
- (iv) The observance of *ahimsā* interferes with the enjoyment of pleasures of taste.
- (v) *Ahimsā* obstructs the realization of dreams of world-power.
- (vi) Several *Jainas* care for and protect lower creatures and small insects like ants and bugs but their conduct towards human beings is cruel.¹¹¹ *Ahimsā* described as the highest form of *dharma* is responsible for this attitude.

CHAPTER XI

SUMMARIZATION AND EVALUATION

Each and every religion, worth the name, has accepted the "doctrine of *ahimsā*" as a basic principle. By way of corroboration I may mention that the essence of the eighteen *Purāṇas* has been expressed by Vyāsa in two phrases : to do good to others leads to merit ; and to cause pain to

¹⁰⁹ This is why Mahātmā Gandhi who has been experimenting upon truth for all these years and who is an advocate of *ahimsā* declares that in a particular case or cases he committed *himsā* mistaking it for *ahimsā*.

In *Practical Non-Violence (and Ideology of Non-Violence)* its author K. G. Mashruvala says on page 8 :

"*Practical Non-Violence* may be thus defined as just selfishness without malevolence and with a touch of benevolence."

¹¹⁰ The *Bauddha* view about *ahimsā* is criticised in *Sūyagaḍa* (I, 1,2,24-32; and II, 6,26-28).

¹¹¹ In *Gāmaḍum bole che* there is a chapter named as "*Jīva-Dayā*." Here its author ridicules the idea of the *Jainas* who protect lower types of living beings and neglect higher ones.

others is sin.¹¹³ Gautama Buddha has been designated as the "Lord of Compassion"; and the Allah of the Muslims is called Al-Rahman (the Benificent) and Al-Raheem (the merciful).

It is high time that force—brute force—is soon replaced by persuasion, accommodation, tolerance and mutual service, all based upon reason. Further, *ahimsā* should be accepted as a creed. Then world welfare will no longer remain a dream to be realized.

Ahimsā has acquired a world-wide recognition owing to the various efforts made by Mahatma Gandhi¹¹³ with whom non-violence is an article of faith and who has been consequently all the while trying to achieve independence for India and thereby that of the entire world by following and preaching the gospel of non-violence.

The motto of the civilized man should be "kill not for food, ornament or sport." For the world is not deliberately cruel. It is but custom and thoughtlessness that supports a cruel practice. Lord Mahāvīra and his apostles insisted, and insisted rightly, that we should not even injure life—much less kill any living being in sacrifice or in sport.

Bhāva-himsā cannot cease to be *himsā* by mere force of circumstances. It may be excusable or slightly harmful in certain circumstances but it can never be commendable.

From the story of Dharma-vyādha (virtuous butcher) some may be tempted to infer that *ahimsā* is not always or strictly practicable. Even if we agree to it, "it cannot detract from the merit of conduct conforming to this principle or from the value of the ideal as a humanizing influence in the formation of character."¹¹⁴

The principle of *ahimsā* does not debar a man from discharging his duty. It preaches him that he should do it humanely, considerately, honestly—without the least malice and without the slightest intention of causing injury to another. The practice of *ahimsā* in the case of the *Jaina* house-holder, is thus a question of degree, and it varies with his capacity and his spiritual limitations.

*Ahimsā*¹¹⁵ along with its four ministers viz. truth etc., is a surety for the optimum of faultlessness available in this world, and this optimum is attainable by only such persons who have no attachment whatsoever.

The doctrine of *ahimsā* guarantees a state of perfect harmony between the well-being of an individual and that of the society, whatever the

113 "अष्टादशपुराणानां व्यासस्य वचनमिदम् ।
परोपकारो हि पुण्याय पापाय परपीडनम् ॥"

113 While going through the proofs I may say that he, an apostle of *ahimsā*, has been assassinated, as alleged, by a Brāhmaṇa !

114 See *Evolution of Hindu Moral Ethics* (p. 184).

115 For its synonyms see Ch. V (pp. 112-114). *Niyama* occurring in *Āyāra* (s. 80) is interpreted by Śīlāṅka Sūri as *ahimsā* and *chāra* (*Āyāra*, s. 103) as *himsā*. Vide his com. (p. 109b and p. 132b respectively). *Jīva-dayā* is another synonym for *ahimsā*. It is used in *Nandī* (s. 47).

conditions may be. It further ensures the maximum happiness for the maximum number not only of human beings but of all living beings.

In order that the vow of *ahimsā* may be fully maintained one should not even *think* and *speak* of injuring life nor *even permit* nor *encourage* others to do so.

Ahimsā, when properly and fully observed, makes the mundane living being attain self-realization, makes it finally and entirely free from all encumbrance, makes it a perfect soul and soul only and makes it possess the highest type of knowledge, perception, valour, joy and bliss.

Ahimsā is annihilation of cruelty, a complex of fear, anger and pride and thus manifestation of ideal conduct—character.

Ahimsā is of the highest theoretical as well as practical importance.

Ahimsā is one of the means for the stoppage of *karmans* whereas *himsā* is one of the channels for the influx of *karmans*. Vide *Paṇḍavāgarāṇa* II, v. 2 and I, v. 2 respectively.

In *Hindu Ethics* (p. 111) there is a following observation with which I fully concur :—

“The principle of *ahimsā* was and is interpreted by the Jains in a far more rigorous way than by the Buddhists.”

It may even be said by some that the emphasis laid upon *ahimsā* is carried to the point of exaggeration. But it is better to exaggerate than to underrate the virtue of *ahimsā*.

Ahimsā is not a cover for cowardice but it is a sheath of self-control meant for a true hero on the battle-field of self-conquest.

Ahimsā is not merely a negation of *himsā*. Not to commit *himsā* is not tantamount to *ahimsā*. For, even a worst butcher does not kill one and all the animals. Thus he does refrain from taking lives of several animals. But, on that account he cannot be said to have observed *ahimsā*, and, in spite of this, if we do, we have to give a certificate to one and all the living beings that they observe *ahimsā*, even when they do not make the least attempt to observe it. So, from this, it must have been realised that so far as *ahimsā* goes, it is not enough not to commit *himsā* after all, but one must avoid it with full intention and deliberation, i.e. in short, one should take the solemn vow of abstention from *himsā*. To be explicit, I may apply this principle to *abhaya dāna* (assurance of safety). One cannot say that one has bestowed this gift to the animal kingdom unless one has ‘vowed not to eat meat’.

The feeling of universal brotherhood and that of benevolence as well, can be easily cherished by a true devotee of *ahimsā* as he has all friends and no foes. Appreciation of merits, no matter where found, is a virtue worth cultivating as it leads to serene joy, again an offspring of *ahimsā*. Compassion for the afflicted is a boon, when acquired, and equally so is detachment—indifference when resorted to, in the case of hopelessly incorrigible persons. These, too, are the products

of *ahiṃsā*. Thus the above-mentioned four virtues are the four pillars on which an aspirant of omniscience and ideal character can build up his palace of purity. These virtues when cultivated, ensure such an amount of bliss and peace within the whole brotherhood of living creatures that they ought to be universally adopted and acted upon to the benefit of one and all the living beings.

Just as *anekāntavāda* is the sole judge to decide the validity of a metaphysical speculation or principle so is *ahiṃsā* in the case of an ethical one;¹¹⁶ for the latter is the only fundamental ethical virtue of Jainism, and so judgment on all actions that constitute the conduct of the *Jaina* laity and clergy is to be passed in accordance with the standard of *ahiṃsā*. This is why the *Jaina dharma* is defined as under :—

“एषाद्वेदे वर्तते यस्मिन् पक्षपातो न विद्यते ।
नास्त्यन्यपीडनं किञ्चिद्धर्मः स उच्यते ॥”

This when rendered into English means : That *dharma* wherein there is *syālvāda*, which is free from partiality and where there is no room for hurting a living being even slightly is called “*Jaina dharma*”.

In the end, I may mention that I can multiply instances for additional substantiation of some of the features of the “Doctrine of Ahiṃsā” discussed by me, but I refrain from doing so. What I, however, desire is that veteran scholars interested in this grand principle of *ahiṃsā* may be pleased to make a comprehensive study of the materials suggested in the bibliography (Appendix III) and thereby bring to light whatever may have been wanting in this paper—an outcome of an humble attempt which has been possible in view of the “Research Grant” given to me in October, 1944 by my *Alma-mater*, the *University of Bombay*. I therefore take this opportunity of thanking the *Grants Utilization Committee* in particular and the University in general to which I am already indebted for corresponding grants in the past.

APPENDIX I

Abstention from *rātri-bhojana* (meals at night).

[The five *aticāras*, four varieties of *rātri-bhojana*, and reasons for not taking meals at night.]

Five aticāras :—1. *Uvāsagadasā* (I, s.7, p. 6a) ‘uvabhoga-paribhoga’ is said to be of two types according as it pertains to food or occupation—means of livelihood. As regards the first type the author mentions five *aticāras* viz. (1) *sacittāhāra* i.e. taking animate objects as food, (2) *sacittapratibaddhāra* i.e. taking as food articles which are in contact with animate objects, (3) *ajvalitauṣadhibhakṣaṇatā* i.e. using for food unboiled—uncooked *auṣadhis*, (4) *duṣṣrajaḥkṣaṇatā*, i.e. eating such *auṣadhis* as are not properly cooked, and (5) *tucchaaṣadhibhakṣaṇatā*, i.e. eating such *auṣadhis* as are stuffless.

¹¹⁶ I fully agree with Satkari Mookerjee when he makes the following observation in his work *The Jaina Philosophy of Non-Absolutism* (p. 302) :—

“The Jaina Ethics of *ahiṃsā* (non-injury) has its counterpart in Jaina metaphysics also.”

In this connection Abhayadeva Sūri in his com. (p. 9b) on this *āgāna* says :

The five *aticāras* mentioned here are merely indicative and not exhaustive. So those who have taken a vow of abstaining from taking honey, wine and flesh have several other *aticāras* arising from *anābhoga* (inattentiveness), and those who have taken a vow of refraining from meals at night have some arising from *atikrama* (transgression).

Abstention from taking meals at night is recommended to the *virata Jainas* i.e. *Śrāvākas* and *Śrāvikās* in connection with their second *guṇa-vrata* viz. setting a limit to their *bhogas* and *upabhogas*. They are not expected to be so rigid in their observance of these recommendations as the clergy ; for the former give up taking only two varieties of food *aśana* and *khāḍima* out of four, whereas the latter all the four.

Four varieties of rātri-bh-jana—Haribhadra Sūri in his com. (pp. 149b-150.) on *Dasaveyāḍīya* (IV, 9) says that *rātri-bh-jana* is four-fold according as it refers to *dravya*, *kṣetra*, *kāla* and *bhāva*. By *dravya* are meant *aśana* etc. ; by *kṣetra*, two and a half continents and oceans i.e. *manuṣya-loka* ; by *kāla* night etc. ; and by *bhāva* attachment and aversion . Further, he says that *rātri-bh-jana* is four fold from its nature only : (i) one accepts food at night and eats at night, (ii) one accepts food at night and eats by day, (iii) one accepts food by day and eats at night and (iv) one accepts food by day and eats also by day. Over and above these there are four *bhaṅgas* (varieties) of *dravya* etc. in the enjoyment of *sannidhi* (storing up for the next day) as under :—

- (a) One eats at night by *dravya*, but not by *bhāva*.
- (b) One eats at night by *bhāva* but not by *dravya*.
- (c) One eats at night by *dravya* and by *bhāva*.
- (d) One eats at night neither by *dravya* nor by *bhāva*.

Of these the first variety arises when one eats at night by believing that the sun has arisen, though not so and that the sun is not set, though set.

One wishes to eat at night but does not get anything to eat. This is the second variety.

One wishes to eat at night and gets food at night and eats it. This is the third variety.

The fourth *bhaṅga* is void.

Reasons for not taking meals at night—Hemacandra advances in his *Yogśāstra* (III, 48) and its com. the following arguments as to why one should not take meals at night :—

(1) One should not eat food at night ; for, at that time, food is made polluted—uncatable by *Pretas*, *Pisācas*, and others¹¹⁷ who roam about without any check.

(2) Who would eat at night when insects¹¹⁸ falling in the catable¹¹⁹ are surely invisible as the (objects of the) sense of sight—eyes are obstructed by terrible darkness ?

(3) An ant destroys intelligence, a louse causes dropsy, a fly vomit, a spider leprosy, a thorn and a piece of wood pain in the throat, a scorpion fallen in vegetables pierces the palate,¹²⁰ and a hair stuck to the throat causes indistinctness of utterance.¹²¹

These faults¹²² associated with night-meals are known to all.¹²³

(4) When meals are taken at night, (a) food is cooked at night, and that means destruction of six types of living beings, (b) there is destruction of insects associated with water in washing etc. of pots, and (c) there is destruction of *kunthus*,¹²⁴ ants etc. lying on the ground, in spilling water.

(5) One should not eat¹²⁵ even inanimate (*prāsuka*) substances¹²⁶ at night, when small insects¹²⁷ are invisible.¹²⁸

¹¹⁷ *Rākṣasas* and the like.

¹¹⁸ Worms, ants, flies etc.

¹¹⁹ Clarified butter, oil, whey, etc.

¹²⁰ The stalk of a vegetable named 'vārtāku' resembles a scorpion, and so if a scorpion falls in such a vegetable, it may not be seen.

¹²¹ This is supported by a quotation by Hemacandra on p. 167b as under :—

“मेहं पिपीलिआक्षो हणन्ति वमणं च मच्छिद्यो कुण्ड ।

जूया जलयरसं कोलियओ कोढरेणं च ॥

बालो सरस्व भङ्गं कण्ठो लग्गइ गलम्भि दाहं च ।

तालुम्भि विन्धइ अली वज्जणमज्झम्भि भुज्जन्तो ॥

¹²² As stated in *Arthadīpikā* (p. 116a), *Nisīha-cunṇi* says that if an article of food mixed with a limb of a lizard is eaten, lizards get generated in the belly.

¹²³ See *Arthadīpikā* (p. 116a).

¹²⁴ This is supported by a quotation by Hemacandra on p. 167b as under :—

“जीवाण कुन्थुमाईण चायणं भायणधायणाईसु ।

एमाइ रयणिभोयणदोसे को साहिउं तरइ ? ॥”

¹²⁵ This is what is said in this com. (p. 167b).

¹²⁶ Sweatballs, fruits, etc.

¹²⁷ *Kunthus* and *panakas*.

¹²⁸ These arguments are supported on p. 168a by a quotation from *Nisīha-bhāsa* by Hemacandra as under :—

“जइ वि हु फासुगदव्वं कुन्थू पणगावि तह वि दुप्पस्सा ।

पच्चक्खनाणिगो वि हु राईमत्तं परिहरन्ति ॥

जइ वि हु पिपीलगाई दीसन्ति पईवमाइउज्जोए ।

तइवि जल्ल अणाइमं मूलवयविराइणा जेण ॥”

(6) Taking meals at night is not recommended—is prohibited by the omniscient.

(7) Even the *Vaidikas* say that to take meals at night is undesirable.

Persons conversant with the *Vedas* say that the sun possesses the lustre of the three *Vedas*. One should perform all good acts purified by him. To be explicit, at night one should not offer any oblation, should not take a bath, should not perform a *śrāddha*, should not worship the Deity, should not give a donation and especially should not eat at night.

(8) One should know that the *nakta* is the eighth part of the day when the sun becomes dull, and not that taking meals at night is 'nakta'.

(9) Gods eat in the four-part of the day, sages at noon, the manes in the latter part of the day, *Daiṭyas* and *Dānavas* in the evening, and *Takṣas* and *Rākṣasas* in the evening—twilight. Oh Yudhiṣṭhira ! to take meals at night barring all these periods is taking no meals.

(10) When the sun sets, the heart-lotus and the navel-lotus become contracted. So one should not eat at night.

(11) Subtle insects are likely to be eaten at night. So one should abstain from it.

(12) How can those silly persons be distinguished from *Rākṣasas*—the persons who take at night food wherein *Jīvas* fall from all sides ?

(13) One who eats by day and at night as well is really a beast without horns and a tail. He adds : Meritorious is that person who, knowing the faults associated with meals at night, eats two *ghaṭikās* after sun-rise and two *ghaṭikās* before sun-set.

(14) Those who eat at night, leaving the day, are foolish enough to let go a ruby and accept a glass.

(15) Those who eat at night with the desire of attaining welfare, even when they can take their meals during the day, sow śāli rice in a soil impregnated with salt, even when there is a puddle.

(16) Those who take meals at night become an eagle, a crow, a cat, a vulture, a Śumbara (a kind of antelope), a pig, a serpent, a scorpion, and a *godhā* (? lizard).

(17) Vanamāiā made Lakṣmaṇa swear by the night meals, leaving aside other oaths.

(18) That blessed person who abstains from taking meals at night, has his or her half the life-period spent in fasting.

(19) Leaving the omniscient personage, none can enumerate various other advantages of abstaining from taking meals at night.

Hemacandra says in *Yogaśāstra* (III, 64) that one who eats by day, does not get the merit of not eating at night, unless he or she has taken the vow to that effect. For, how can one get interest on the money lent or deposited unless he or she has specifically asked for it?

To the nineteen arguments mentioned above I may add the following occurring in different works :—

(1) In *Nisīha-bhāsa* it is said that though ants, etc., can be seen in the light of a lamp, etc., even then taking meals at night is *anācīṇa* as it causes *virāḥanā* to *mū'a-guṇa*.¹²⁹

(2) In *Arthātīpikā* (pp. 116a-116b) the following corroborative evidences are cited :—

(a) Even when only a relative dies there is certainly a *sū'aka*. So how can food be taken when the lord of the day (*i.e.* the sun) has set?

(b) Waters become blood and food flesh.

(c) Oh Yudhisthira ! even water should not be drunk at night especially by a *tapasvin* and by a house-holder who is discriminate.

(d) Those intelligent persons who give up taking meals at night for ever, get the fruit of fifteen fasts by the end of a month.

(e) In *Skanda-purāṇa*, in the 'Kapāla-mocana-stotra' composed by Rudra it is said : By taking food once one always gets the fruit of *agnihotra*. One who always refrains from taking meals at night, gets the fruit of *tīrtha-yātrā*.

On pages 261-262 of *Yogaśāstra* by G. J. Patel it is said :

In *Dvī-purāṇa* we have this verse with this difference that there is the word 'nakta' for 'rātri'.

Nakta-vrata means to eat during the 'nakta'. According to *Vyāsa* the period of three *muhūrtas* from the sun-set is called 'pradeśa' and to observe 'nakta' at that time *i.e.* to eat at that time is a rule laid down in the scriptures.

In *Bhaviṣyaṭ-purāṇa* it is said that 'nakta' is defined by the learned as the period of one *muhūrta* before sun-set, but I look upon 'nakta' as the time when constellations become visible.

Dvāla-smṛti says : 'Nakta' for the laity is the time when constellations become visible, and, for the *yatis* it is the eighth part of the day, for the *yatis* are forbidden to take meals at night. The *yatis* and the widows should look upon the last two *ghaṭikās* of the day as 'nakta', while the house-holders the first half of the first part out of four of the night.

¹²⁹ The pertinent *śūtra* along with one more is quoted in the *svopajña* comp. (p. 168a) on *Yogaśāstra* (III, 63).— See Ln. 128.

Skanda-purāṇa says it is 'nakta' when the sun goes down so much so that one's shadow becomes double in length. 'Nakta-vrata' does not mean taking meals at night. So one who wants to observe this vow, should take the meals in the evening.

One should not eat in the mid-night. Such a prohibition is met with in the *Brāhmaṇa* works, but it is not said that meals should be taken by day only. At the time of *sanḥyā* one should not resort to taking food, sexual intercourse, sleep, and study.

In the Gujarāṭī explanatory notes (pp. 505-9) to *Adhyātma-tattvārka* some verses are quoted as corroborative evidences. I may note their meaning as under :—

(a) Mārkaṇḍa muni has said that when the sun has set water is called blood and food is like flesh.

(b) In *Kūrma-purāṇa* (adhyāya XXVII, p. 645) it is said: One should not injure any living being. One should remain free from *dvandva* (regard for pairs of opposite feelings) and fear, one should not eat at night, and one should remain engaged in meditation at night.

(c) In this very *Purāṇa* (p. 653) we have : On showing food to the sun, a person while facing the east should eat it.

(d) The intelligent say that 'nakta' is the last *muhūrta* of the day. Oh Gaṇapati ! I do not believe that 'nakta' arises from seeing constellations.

(e) What a strange thing it is that when the orb of the sun is covered by a collection of clouds the devotees of the sun do not take food but they do so when he has set !—p. 508.

In these notes (pp. 504-5) it is said that several subtle insects begin to fly as soon as it is twilight. Hundreds of insects are seen going round a lamp at night. A good many of the insects are seen falling in a *āṇḍī-pāra* (lamp-pot) kept open. Further, no sooner is it night-time than several *jīvas* begin to sit on our body. So under these circumstances insects must be sitting on eatables at night. Consequently one who takes meals at night incurs the sin of eating these insects.

Satisfaction is the root of the religion based on *tyāga*. So it is desirable that the activity of taking meals at night should end at night along with other activities of the day. This will give some rest even to the belly, and it may lead to good sleep, observance of celibacy and good health. Vide *Tattvārthavivēcana* (Hindi, p. 270).

APPENDIX II

Select narratives pertaining to Ahimsā and its partial transgressions.

(1) *Uvaśapaya* (v. 506-510) by Haribhadra-Śūri and its com. (p. 253a ff.) by Municandra Śūri.

(2) *Uvaesapaya* (v. 550-557). This pertains to the observance of minor vows and abstentions from taking meals at night.

(3) *Uvaesamālā* (v. 13 & 319) by Maladhariya Hemacandra. The author in his own com. on it gives Dharmaruci-kathā and Vajrā-yudha-caritra.

(4) *Kahārayanakosa* (Jannadevakahā, pp. 240b-247b) by Devabhadra Sūri. This includes five sub-stories pertaining to five partial transgressions of the first vow. They are : (1) Mihira-kahā (p. 243b-244a), (2) Varuṇa-kahā (pp. 244a-244b), (3) Liāval-kahā (pp. 244b-245a), (4) Mahu-kahā (pp. 245a-245b) and (5) Dhara-kahā (pp. 245b-246a) respectively.

(5) *Kumāravālapad'boha* by Somaprabha Sūri. Here, on pp. 23-28, there is Amarasūha-kahā and on pp. 28-33 Dāmannaka-kahā each dealing with compassion on living beings. On pp. 313-320 we have Sivakumārakahā where the topic of refraining from *hiṃsā* is expounded.

(6) *Nāyālhammakahā* (Megha-kumāra-kahā I, I; and Daddura-kahā I, 13).

(7) *Mahāvīracariya* (Harivammakahā, pp. 293a-298a) by Guṇacandra.

(8) *Yogaśāstrabā'āvabodha*¹⁸⁰ by Somasundara Sūri. For stories see the next work.

(9) *Yogaśāstra-svopajñā-vṛtti* (Subhūma-kathā, fruit of *hiṃsā*, pp. 72a-75b; Brahmādatta-kathā, fruit of *hiṃsā*, pp. 75b-90b; (Kālasaukarika-putra) Sulasa-kathā, abstention from *hiṃsā*, pp. 91a-95b).

(10) *Vāsūpūjacaritra* (IV, v. 182-244) by Vardhamana Sūri. This story deals with *ahiṃsā*.

(11) *Vivāzasuya*. Its first part mentions evil effects of committing *hiṃsā*.

(12) *Samyaktva ane bāra vratonī kathā*¹⁸¹ (Sūra-Candra-kathā) by Taruṇaprabha.

(13) *Supāsanāhacariya* (pt. III) by Lakṣmana Gaṇi.

THE CHINESE ORIGIN OF THE WORDS PORCELAIN AND POLISH

BY S. MAHDIHASAN

HOBSON-JOBSON, of Yule and Burnell, gives a history of the word porcelain, quoting such classical sources as Samuel Johnson's first English Dictionary. As none of the explanations appear to me probable I am forced to make brevity a virtue and dispense altogether with a historical and a critical introduction to the subject. However a few apparently disconnected notes are taken from Yule and Burnell as they support the Chinese origin of the word.

S.W. Bushell, writes in his *Chinese Art*, 1910, Vol. 2, p.1, that "Porcelain was certainly invented in China. This is acknowledged, as it were, in English, by the adoption of the word, 'china,' as equivalent to porcelain and even in Persia, where Chinese porcelain has been known and imitated for centuries, the only country to which an independent invention has been plausibly attributed by some writers, the word 'chini,' has a similar connotation." Since China is the home of porcelain, it is very conceivable that the original or indigenous term given by the inventors has also travelled along with their wares. Foreigners, who did not have a long contact with the Chinese and were thus not in a position to borrow, would nevertheless feel the necessity of calling porcelain by some name. It may not be a proper translation of the original term or even a paraphrase of it but expediency would suggest some substitute as long as the name indicates the specific wares. The easiest term would be to call them after the country of their origin and china and chini are such names which the lay public could at once appreciate. The Persians, with a limited sea-faring activity, have not gone beyond substituting for the word porcelain the word 'chini' and the Europeans apparently did the same in the early days of their contact with the Chinese, but while their visits to China became frequent they gradually became aware of the term by which the Chinese themselves called these wares.

Bushell says on p. 2, of his work that "The Chinese define porcelain under the name Tz'u, a character first found in books of the Han dynasty, B. C. 206 —A. D. 220." This word Tz'u is given in the *Chinese Dictionary* by Giles, 1892, as character No. 12407. It forms the main word in the term Po-Tz'u-Lan, the Chinese original from which porcelain has been derived. In Chinese the word Tz'u cannot be used by itself which requires a little explanation.

Chinese, like any other language, is rich in words, each with a specified range of meaning and having a written character of its own but, being a monosyllabic language, the words as pronounced are very limited in number, so much so, that they offer difficulty in ordinary conversation. Imagine a very brief conversation in English where an enquirer is answered, "he went to the bank." The word Bank has two meanings or rather two distinct words have a common or identical

pronunciation. A better answer would have been "he went to the riverbank," or "he went to the commercial-bank." The Chinese resort to the device of adding such epithets to qualify the main word ; sometimes they add a synonym to confirm its meaning. Just realize that there are actually seven words with exactly the same pronunciation and accent as Tz'u so that if this word were to be heard by itself it would be any one of the seven words written separately and having different meanings.

The word Po, character No. 9333 in Giles, meaning Glass, has been added as an epithet. Since there are no adjectives in Chinese Po-Tz'u also means Glassy-Porcelain. It would be admitted that the determinative epithet glassy, has been very appropriately chosen. The same word Po has also given rise to another derivative, the word polish.

Giles also gives the term Po-Li while discussing the word Po. He says that Po-Li is the original of the word polish. Li is found as character No. 6998 and means Lustre of pearl, when it is used as a substantive, but as adjective it would signify pearly. Po-Li would then mean Glassy-Pearly two words with allied meanings used to remove doubts as to which Po or which Li is meant when either of them had been used alone. Strange enough Giles does not mention that the words Po-Li by themselves do not convey the complete sense ; they are after all adjectives and must qualify some substantive which is wanting. Se is the main word meaning Colour or Looks and is given by Giles as character No. 9602. Giles says that it is pronounced Shai in the north ; hence the complete term, as spoken there, would be Po-Li-Shai, and this alone could have given rise to the derivative Po-Li-Sh, which condensed becomes Polish. Po-Li-Shai means Glassy-Pearly-Shine, a remark that applies to high class furniture well *polished* and looking like a mirror.

Po then is a word already familiar to us through Chinese lacquers bearing ideal polishes. If wood lacquered can look polished or glassy, wares made of kaolin actually glazed with glass can be even more so. Po was therefore also added before Tz'u which makes the term Po-Tz'u signifying Glassy-China. The adjective glassy does not qualify any special kind of china but specifies the word Tz'u which has several meanings as mentioned before ; only the term Po-Tz'u could connote china in conversation, although Tz'u when written, as character No. 12407, would perfectly convey the meaning. Po is redundant when written but absolutely essential in conversation.

Porcelain is a generic term as has been explained by Bushell on p. 13, of his *Chinese Art*. On p. 16 he says that, "In Chin dynasty, 265-410 A. D., we have the first mention of blue porcelain." It is further mentioned on p. 15 that "The glaze of Chinese porcelain always contains lime. It is the lime which gives it a characteristic tinge of green or blue." Thus Chinese porcelain would mostly be blue while a particular variety of it far more so. It is therefore this artistic porcelain that is meant by the term "blue porcelain." Blue in Chinese means Lan, character No. 6732 as given by Giles, so that Po-Tz'u-Lan would signify Blue-Porcelain to distinguish it from other less artistic wares. If we look at any old collection of china, blue is invariably the most predominant colour. Blue china has been held as the most favourite. Bushell says for example that, "In the province of Honan the best was blue (porcelain), rivalling, we are told, the azure-tinted blossoms of the

Vitex incisa shrub, the sky-blue-flower of the Chinese (p. 22).” For the same reason Bushell mentions of a *Catalogue of Blue and White Porcelain*, printed in 1895, on page 32, where there is no mention of any colour other than blue ; nevertheless the collection was large enough to have a published list of its own. Po-Tz’u-Lan then is the best and the most prized china, the blue china, and this term has given rise to the derivative porcelain. Porcelain is not pronounced exactly so in all European languages. Even in English an old writer, Evelyn, in 1652, as cited by Yule and Burnell, spells it as Porcelan which is nearer the original Chinese. When the French would pronounce Po-Tz’u-Lan, they would introduce an R so that the term can be transliterated as Po-R-Tz’u-Lan or Porcelan. Lan, thus, is the last word of the Chinese term while it forms the last syllable of the first loan word porcelain.

That blue is synonymous with the best porcelain can be confirmed by other independent considerations. A. Reichwein, in his book, *China and Europe*, London, 1925, on p. 44, speaks of “Embroideries on blue satin picked out with silver after the manner of porcelain, on a ground of gold material. Obviously this kind of porcelain-like embroidery is to be referred to the model of a certain Oriental material to be found among the imports before mentioned which had been forbidden by Luis XIV and XV. This was a cotton material with a blue pattern on it and was for that reason actually called *pourcelaine*.” Here we find that not merely the best china was blue but that porcelain itself meant blue ; it was *the* colour of porcelain. In this light it becomes clearer how the Chinese have added the epithet Lan, or blue to the term Po-Tz’u, or china.

The history of Chinese enamel wares again confirms the significance of the word Lan. During the reign of the Chinese Emperor of the Ming dynasty, Ching-T’ai, who ruled between 1450-56 A. D. (Bushell : Explanation to Fig. 86, p. 77), cloisonne enamel wares were introduced. They could have been called Ching-T’ai-China in honour of that Emperor just as the Persians have named a special kind of sword “Abbas” because it was introduced during the reign of Shah Abbas. Ching-T’ai-Tz’u would have likewise meant Ching-T’ai-China but the Chinese have preferred to call it, by a more complimentary name, Ching-T’ai-Lan or literally Ching-T’ai-Blue. We have seen above that even in French ‘blue’ meant porcelain, which is also true in China for Ching-T’ai-Blue means Ching-T’ai-China. Lan or blue is thus the more complimentary synonym for china. Giles gives under character Ching, No. 2143, the term Ching-T’ai-Lan as connoting Cloisonne Enamel Work.

SUMMARY

The Chinese term Po-Tz’u-Lan literally means Glassy-China-Blue from which is derived the word, Porcelain, with a former spelling of Porcelain, nearer the Chinese original. The word Po, in the above term, is also found again in Po-Li-Shai, meaning Glassy-Pearly-Shine, which has given rise to the derivative polish. Lan, the last word in the term, Po-Tz’u-Lan also ends in the term Ching-T’ai-Lan or Emperor Ching-T’ai-Blue. In this term Lan literally means blue but stands for the best kind of china. Ching-T’ai-Blue signifies the very best kind of china which was introduced in the reign of Ching-T’ai and in Chinese means cloisonne.

THE LIMITS OF PHILOSOPHY

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THE position which I wish to advance and to defend in this short article is that the real limits of philosophy are constituted by the possible or likely truth of some systems of philosophy—systems which have been severely criticized and even ridiculed but which nevertheless do not seem to me to be satisfactorily refuted. Foremost among such systems are, materialism or the view that the real is ultimately material and is governed by mechanical laws, and subjectivism or the view that the real is nothing but the experience of an individual experient. In the event of either of these or any similar philosophical theories being correct and being the whole of the truth, philosophical knowledge becomes meaningless, unreal or altogether subjective and proves to be very seriously limited. I do not think that it will require much argument to prove that if materialism is completely true, philosophical knowledge and indeed any knowledge can have hardly any significance ; or that if subjectivism or sensationalism is a correct statement about knowledge, knowledge is reduced to something so relative and undependable that it loses all its objectivity and validity. I shall later show in some detail how this is necessarily so.

But the really difficult task which faces me is the earlier one—of showing that situated as we are, we may dislike, disapprove of, and find difficulties of various kinds in theories like materialism and subjectivism and perhaps even succeed in proving that an intelligible statement of them is impossible but we can never fully refute them and that on the other hand there are many positive proofs of their possible truth. I am quite aware of the overwhelming odds against me and might frankly admit that as a normal human being I wish that my doubts and fears should be proved false and that these most undesirable doctrines should really be fallacious. But as a loyal votary of philosophy it is my duty to give expression to the lurking fears I entertain—fears which make all my attempts at philosophizing and indeed at any voluntary action futile and unreal. It may be, that I may in the end, be so able to accommodate these fears that my philosophical views may become profounder but in any case I must take the risk and continue to think persistently even on matters which unsettle me, hoping for the best, if I must hope.

I do not, in this paper, adopt or even consider the position generally adopted that the limits of philosophy arise because of its intellectual or rational approach or because of its exclusively theoretical outlook. It is often maintained e.g. that religion, or art or life give us a fuller hold on, and comprehension of reality than philosophy. There is something to be said for such a view, but there is equally something to be said against it. Personally, I do not think that it is fruitful or just to compare different types of approaches and try to grade them

What the one lacks, the other has, but what the other lacks the first has—so that it could equally well be said *e.g.* that the limits of religion are constituted by philosophy—and that without the truth which philosophy supplies, religion would be a merely subjective affair. My own view is that Philosophy is one of the ultimate approaches to the Real and is on a par with other ultimate approaches. It has characteristic defects and excellences but at its best, it secures for its votary all that any other approach—or pathway secures for its votaries. At its worst as we know, no pathway secures anything for any one !

The difficulties which I am raising in the domain of philosophy have of course a wider application and will make not only philosophy but religion, art, literature, science all thoroughly meaningless and unreal in the sense in which we understand them. If materialism or subjectivism are the full truth of things, what room can there be for God, or Beauty or Goodness any more than for truth, scientific or philosophical ?

Let me now state why in my opinion we have got to treat materialism and subjectivism with greater respect than they have commonly been and why we cannot leave them out of the final world-view which we hope to be provided with, by our philosophical activity. Materialism maintains on the basis of observed facts of experience that the real behind the appearances which philosophy seeks is material, natural and mechanically governed and conditioned. It points to the large domain of our experience of ourselves and nature which is adequately explained by material laws and suggests that what has yet not been so explained could in time be allocated its place in the mechanical scheme.

That this is a thoroughly clear and *prima facie* sound metaphysical hypothesis whether or not an ultimately and fully acceptable one need really not have been a matter of controversy at all. But that actually is the case and Materialism has been almost ruled out of court by a large consensus of philosophical opinion, both in the East and West as a thoroughly absurd and untenable as well as an undesirable theory. Curiously enough, while materialism in a practical sense has represented the practice of humanity there has always been a reluctance to recognise it as even a respectable doctrine theoretically. Great systems of materialism have certainly flourished from time to time in all countries, nevertheless the bulk of philosophical thought both at high level and chiefly at lower levels has been against materialism and in favour of some kind of idealism. It would be interesting from a psychological point of view to suggest the causes of this partiality. Although I believe that the psycho-analyst explanations are often farfetched, I do feel that this is one of the cases in which the conscious and respectable ego is seeking to domineer over and keep down the natural tendencies of man and then take back in practice what is given up in theory and *vice versa*. Personally, I also believe that the adoption of such an attitude towards materialism has actually resulted in making man not less but more materialistic in practice. For what it is worth, I may say that my personal conviction is that the only method of making Indians, for example, less materialistic in practice than they are is to encourage the growth, development and understanding of materialism in the theoretical sense among Indian students of philosophy.

But we are not here directly concerned with all this. Apart from the practical grounds for which materialism has been looked down upon and which are at best irrelevant in philosophy, there have of course been serious theoretical objections urged against it. Let us see if these objections are fatal to materialism and conclusively disprove it.

These objections may be divided into factual and logical ones. It is maintained that the facts of experience reveal the existence of entities which cannot be explained materialistically. That our ideals and aspirations and even many other commoner things characteristic of human experience such as life itself, affection, attachment, judgment, discrimination, sense of value, etc. cannot, without denying their reality, be explained by the mechanical categories of materialistic explanation. To this, the reply is twofold : (1) that while it is true that certain experiences which are of special value to us have not been satisfactorily explained, several such have already been so explained, the process is continuing and there is no scientific reason to disbelieve that the others may be so explained in due course. After all one has to remember that all human ailments, and most human achievements were treated as gifts of fortune, good or bad, only a few centuries ago, but that many of them are already satisfactorily explained by science and controlled to a large extent. In the face of this advancing tide, nothing but subjective inclination can explain the belief that certain other experiences or entities of the same kind can never be explained by scientific methods. Nor is it correct to say that in so doing, science denies the fact of our experience of ideals or values. It only explains them causally and causal explanation of temporal events is allowed to be the most important and useful of all. Materialistic science and philosophy do not and need not deny the factual experience of the value aspect of things. It merely traces it back to its causes.

On logical grounds, it is contended that the position of materialism is self-inconsistent and untenable and partial ; for matter which is the fundamental reality according to materialism and to which we seek to reduce everything is an abstraction ; concretely, matter is experience, an idea, a concept and thus the whole structure of material science is seen to be ultimately of mental stuff only. This position is defective in two ways—(1) it is itself so abstract that it hardly adds to our knowledge. To be told that everything is an idea, is, I think, to be told very little indeed, concretely. We have then immediately to ask ourselves the question what kind of idea we have before us and to start the inquiry once again. But (2) even a more serious difficulty faces us and it is the same which made Hume having reduced everything to ideas explain an idea in terms of a mind in an individual organism. Hume was inconsistent but the situation itself is puzzling. If matter by itself is an abstraction, so is idea or experience another abstraction. If matter implies an idea, idea also in the same way implies matter. Neither its origin, nor its content can be given to experience if matter disappears.

It could also be and has some time been maintained that Materialism, if true, cannot be started ; for its truth will make the statement or indeed any statement meaningless, everything including the statement being the mere result of mechanical causation. The reply is that it is no contradiction of the truth of materialism to say that its

statement is meaningless. Its truth may nevertheless remain unimpaired. In fact, one could even say that it would be in a way a proof of the truth of materialism !

The possible truth or shall I say the partial truth of Materialism then constitutes the first of the Limits of Philosophy in my opinion.

I shall now proceed to consider the theory of Subjectivism which is in almost equal disrepute amongst recognized philosophers and others. The term 'subjectivism' I have used here in its traditional meaning in Western Philosophy. In Indian thought the term has been used with a somewhat different connotation. Subjectivism with us merely means opposition to all forms of mere objectivism and externalism and materialism. Thus the Vedanta is a subjective doctrine in this sense ; but it is not subjective in the Western sense since it posits and is founded on the universal reality of the Brahman which is a subject but not an individual subject. The various schools of Buddhism are subjective in the sense in which we use the word here.

The practical difficulties of such a position are obvious. The whole of our practical life—physical and mental—seems to give the lie direct to the fantastic notion that the real is mere subjective experience. Johnson is reported to have suggested as a cure for Berkeley, the great subjective Idealist, that his head should be forcibly knocked against a door of solid English oak. That would teach him that all things do not after all consist merely of unsubstantial ideas but that some of them at least are made of 'sterner stuff.' Theoretically the objection to the position is that it makes all scientific experience and objectivity invalid. There can be no laws and no objectivity on this view. But all our experience points to the contrary. Science does work and enables us to deal with our environment. Besides, the theory cannot even be consistently stated. In order that we should know, hold or establish the truth of subjectivism, something more than a mere subject must exist. Unless there is an objective spectator of the process, there is no succession; to admit that there is one, is to believe in something apart from succession. Similarly to talk about a subject, as subject at all, is to recognise that there is something besides the subject.

Formidable as the objections are, the question for us is whether they are insuperable. And I do not think that they are so. Let us first take Johnson's solution of what he understood to be Berkeley's problem. Actually, Berkeley never said that if you knock against a door, there would not be the experience of a bump on your forehead, or that you would not shout in pain, but only that all this along with the door would be but matter of experience and apart from that would have no existence. Johnson in order to refute Berkeley would have to prove that doors can exist without any one having made them, and that they can knock against one's head although one does not go near them.

It is true that to be told that everything is an idea is not enough knowledge ; the question is whether it is untrue. It is also true that it is not usual so to describe things but science and philosophy cannot always be just usual ; if they are, they would be no less and no more than common sense. As to this theory making scientific knowledge impossible and being thus contradicted by the proved truths of science. In the first place, an objective order may exist even within dream

experience and science may therefore be quite a good account of things within the subjective experience. Subjectivism is an interpretation of facts and to show that it is unsatisfactory, we must show how it fails to explain facts in its own way. It cannot be and is not opposed to facts as such.

Coming now to the theoretical objection about it being impossible even to state the theory etc. what does it really amount to? It does not prove the theory false, it suggests one of its many practical difficulties. The dilemma presented to the theorist is not a sound one and he can certainly choose one horn with impunity. I am not interested in stating my theory or defending it, he would say, but only in its truth. Suppose I am a dreamer having a long dream or a person having an hallucination, it is true that I shall not be able to say that is so, but it will nevertheless be true that I am having a dream or an hallucination. I am here reminded of the answer a Vedantin is supposed to have made to an objector to the doctrine of Maya. The latter pointed out right in the Johnism style that it was ridiculous of a man who thinks that the world of names and forms is unreal, to run away in haste from an elephant pursuing him since the elephant was but a phantom. So, replied the Vedantin, am I myself, my friend and so is my running away!

I shall conclude my attempt to show that the theories of materialism on the one hand and subjectivism on the other (in all their variety and with all consequent doctrines) have never been conclusively disproved by pointing out that the theoretical and practical difficulties of the commonly accepted doctrines in philosophy both in the East and West are not much less formidable. Let us first take objective Idealism in the West and Vedanta with us. The real, we are told, is conscious experience or a system of experience. I would like to ask whether from the common sense or practical point of view such a notion gives us any concrete help or guidance at all. Does it help us to know how the real being one, and spiritual, the diversities and conflicts and mutual relationships arise, and does it in any sense indicate how we are to accommodate ourselves in the situation and deal with our environment or our neighbours? Does it help the human spirit of endeavour, etc. to be told that we are stages or phases of a system of experience each having its own appointed place, or that we are उपाधिगत Brahman? It seems to me that the position is not substantially better than the position of being phases in a long dream, or being mere products or by-products of a vast mechanical cosmos.

Even theoretically these doctrines are not without their difficulties. How and why if one, it became the many, how eternity ever descended into time, are questions of fundamental importance for these theories and admittedly unanswerable. Even for making a statement of these theories, there are serious difficulties. What is the point of view from which we describe the Real? If it is that of the Absolute or Brahman, things ought to be much clearer than they are; if that of the finite how do we ever go beyond it and reach the Absolute or, ब्रह्मन् at all?

Let us now consider theories of Realism in so far as distinct from materialism. Realism is very much in the vogue today in the West as a reaction to extreme forms of Hegelian idealism. The Realist thinkers have undoubtedly helped us to correct a number of old mistakes

in philosophy and clear up many ambiguities and have done valuable work as critics of Idealism. But can we truly say that their own theories whether they are just Realists or New Realists or Critical Realists are fully satisfactory either in logic or in fact? The classical refutation of all Pluralism by Bradley applies to most forms of Realism. (The many in order to be many, must be together *i.e.*, related and therefore not many.) Secondly, the view that the Real exists independently of the one is at best an improvable proposition since not a single case of real can be shown which is really independent of experience. And practically, the problem which Realism has to face, is to explain how and why there is interaction, and interrelation at all between mind and matter or other reals if they are truly independent?

My purpose in thus indicating that doctrines other than Materialism and Subjectivism which it is usual to accept as sounder philosophical theories have difficulties almost as serious as any they have, is to suggest that if with all their difficulties, they seem acceptable to us, we could perhaps show the same courtesy to these doctrines as well. Of course, Materialism and Subjectivism are not successfully proved, but nor are they refuted. And precisely this applies to all other theories in the field too. My position therefore is that we must take due (not merely critical or subsidiary) account of the stand taken up by these heterodox theories and include them in our philosophical view of the world.

I realize that in a sense to do this is to add to our difficulties. Philosophical knowledge just because of its reach and width is vague enough; it will be vaguer still in a way. To the question what the real is like, we shall not only have to give the reply that the Real is a Universal experience, or one or more independent neutral but add that it is perhaps also or to an extent merely, a subjective fancy, or mere matter. Regrettable as this uncertainty in our knowledge is, it is better than ignorance or refusal to face facts. If we really find that the real has or may have these aspects, is it not better to acknowledge them even if that makes things more complicated, rather than ignore these aspects and seek to simplify and attain precision at the cost of truth? Science and Philosophy should aim at precision but not at the cost of truth.

The obvious practical consequences of the incorporation of Materialism and Subjectivism in the orthodox fold are also somewhat disquieting. A man who has the suspicion that his affections and ideals, and his search of truth and even his God may be just a passing phase of fancy, or a mere accidental effervescence of a mechanical process working itself out, will naturally feel less enthusiastic about it all. But, in the first place, how can we avoid this even if we would, if facts require it? Will our ignoring facts either make our enthusiasm more effective, or can we even, once we know the situation, successfully ignore facts, psychologically? And secondly, could we not even utilize this situation for the toning down of some of our enthusiasms and fanatisms? In fact, I think the world has suffered a good deal from the refusal and failure of people to take a balanced view of things, to temper, or humanize their enthusiasms and their fads. It would not be altogether—undesirable, if all of us realize and learn that the very nature of things is such that it is necessary for us to be cautious and temperate even in our idealisms and our virtuous activity.

I do not know, if you will agree with me but it is my opinion that this is exactly where the truly religious man proves his superiority to the rest. People often look upon him as a man who lacks intensity of conviction and zeal for principles; he on the other hand, acts as he does because *he realizes that even principles are but abstractions, that in God's great world, the foolish and the wicked, the meaningless and the dull, and the mechanical have all a place along with their more respectable opposites and he is therefore tolerant and even appreciative and accommodating to things, persons and events looked down upon and condemned and shunned by all the rest.* If our philosophical knowledge leads us to the theoretical foundation of such an attitude, I believe that no better consummation could be aspired to. And in this matter as in many others, we shall therefore find that in trying to take within the fold, tendencies which we have looked down upon, we shall be doing good not so much to them as to ourselves !

In my opinion, therefore, so far as the tests of philosophy are concerned, we are not in a position to maintain with certainty that one or the other of the theories of these heterodox doctrines is not after all true. And so far as practical life (this is of course included within philosophy in a way) is concerned, none but the specially fortunate can say with any degree of conviction that the game of life in which we all are players is a game with reason and purpose behind it. It is true that to live at all, and certainly to live with efficiency or success, we have to proceed on the assumption that life and existence have a rational scheme but that itself does not prove the truth of the assumption and the events of life often enough contradict it.

What is it, then, that we can make of the possible truth of one or the other of these theories—how can we utilize it most profitably ? I think the most important use we could make of this knowledge would be to cultivate a sense of modesty in all our theoretical and practical undertakings. Agnosticism and scepticism, as is well-known, have the value of making us conscious of the need of circumspection and criticism in our philosophical method and procedure. The possible or partial truth of the metaphysical theories we have mentioned above should have a similar use for us. It should act as a humbling consideration, and should avoid our being too sure of any of our theoretical conclusions and too enthusiastic of any of our practical creeds. Apart from this, of course, from the strictly philosophical or theoretical point of view, the value of knowing and recognising the possible truth of these doctrines is simply the value of recognising that truth. As truth-searchers we have no option but to keep our mind open on all matters—however unsettling the results of such a procedure. It is just at such times that our philosophic faith is on trial and if we are to stand the test well, we must be prepared to admit that all our attempts to organize our experience are made within strange but fundamental limitations such as may mean that all our attempts are thoroughly futile.

In his brilliant essay on *Freeman's Worship*, Bertrand Russell takes up the position that while it is quite certain that all our ideals and idealistic aspirations are but an ephemeral accident of a vast mechanical process, we as beings who feel the call of the ideal have to and ought to respond to it knowing as we do that it is a thoroughly hopeless task.

It is our 'noble' mission to lay down our all in this unequal and hopeless conflict. Actually, I think the position on Russell's showing is even worse than that. The truth of Materialism does not make our task merely hopeless but perfectly meaningless. We must not only possess the idealism to carry on in spite of odds and with no hope of success; we must carry on, acknowledging that to carry on is foolish and meaningless. I do not think that it is psychologically possible thus to wage a battle against forces which are not only insufferable but which are the only thing that is real; and I do not consider either that it is rational to do so.

When mankind is fully convinced of the truth of Materialism, all talk of ideals will have necessarily and rightly to be given up. My own position is merely that neither Materialism, nor some other equally extreme doctrine which undoubtedly have a good deal against them theoretically and practically have been conclusively disproved and that they do have some truth in them. The universe may be, for all we know, just a long and complicated dream experience, or it may be a mere bye-product of a vast mechanical scheme, probably it has both these and several other aspects some of which are of greater natural interest to us. But let us not altogether forget these less liked aspects and let us tone down our exuberances so as to make them less inconsistent with facts which may reveal themselves per chance.

Thus, the purport of my discussion would be that we should hold and act upon a theory of reality which gives their due place to the truth of the theory of Materialism on the one hand and Subjectivism on the other. My contention is that this is not done to the extent and in the spirit that it should be done in traditional philosophical systems which almost brush away these theories as palpably absurd and self-contradictory. I have tried to show that they are not so absurd and contradictory as the critics imagine and that the respectable doctrines offered for acceptance by the critics are themselves riddled with difficulties serious enough and probably as serious as those which face the heterodox doctrines. It is true that such a step may mean the lessening of our ardour in many things, and would make our philosophical knowledge even vaguer than it is. But as I have said above, I do not think that these are necessarily undesirable consequences in the circumstances and on the contrary have certain desirable significance, reality being what it is; and secondly that in any case as searchers of truth, we have no option but to admit facts as we see them.

In this article, I have merely tried to show how certain aspects of the real philosophical situation are usually neglected and why they should not be neglected. The next problem for concrete philosophical thinking would consist in the attempt to synthesize and grade these various aspects of the truth. It may be, we may never be able to do this with full or even substantial success. It may be, when all is said and done that philosophy is a matter of temperament and that each one of us will see only one aspect of truth. But the attempt is undoubtedly worth while making.

BOOK REVIEWS

Some Tasks for Education, by Sir Richard Livingstone. Oxford University Press, 1946.
Price 5 sh.

SIR RICHARD LIVINGSTONE has, now for some years, been dealing with the one fundamental question facing a war-torn world *viz.*, how to improve ourselves and our society by education. In his "Some Tasks for Education," which comprises four lectures delivered before the University of Toronto in 1945, he works out a solution to the question. What the modern world needs, according to him, is not an education based on the social sciences which merely leads to superficiality, nor an education based on Science which leaves out human values entirely, but an education that will humanize man by giving him spiritual ideals to live for. Maintaining that modernity is a question not of date but of outlook, he finds true modernity in the thought and the way of life of the Greeks of the age of Pericles. Hence, it is a classical education that contains 'the vitamins which the mind and the spirit require.' Greek literature and Greek life give the true vision of greatness that is necessary as a basis for moral values. This vision must lead the young to take Excellence as master and to accept the first rate in every sphere of life, in one's job, in national life, in literature and art, and most of all in human character and conduct.

The ultimate aim and essence of education, the author suggests, must be the training of character and this is to be achieved by training children in social behaviour so that they can contribute their share to the four citizenships of the family, the community, the nation and the whole Universe that man is born to. A special chapter is devoted to "Speaking the Truth" for that is the virtue most needed in this age of science in which life is based on knowledge. Ordinarily, the value of it is recognized in personal relations but not in controversies on social and political problems. There is a need for training people to approach human questions in the true scientific spirit. Such training, however, is not given by the study of science but rather by a proper study of history and literature.

In these days when the need for Science and the practical aspect of education is stressed and overstressed, a corrective was necessary to give a sane and balanced view of education. And that is precisely what Sir Richard Livingstone has given by making out a convincing case for the humanities and for a classical education. It was necessary to strike this note at a time when education is tending to be all too technical and vocational.

—S. PANANDIKAR

Gandhi's Challenge to Christianity, by S. K. George, with Forewords by Prof. S. Radhakrishnan and Mr. Horace Alexander. Navajivan Publishing House, Ahmedabad.
Price Rs. 1-8-0.

THE key to this impressive and interesting book of 93 pages is to be found in the following words which the author wrote in 1932 :—"Mahatma Gandhi's life and message gripped me at that time (1921) and they have remained with me as an abiding influence, deepening and vitalizing as the years go by. Above all else they helped me to realize Christ and his message more than anything else. I realized... that the central thing in Christianity is the hope of the kingdom of God and that the Lord Jesus is inviting us to carry on the building up of that Kingdom with the devotion and in the spirit which characterized himself in his life on earth." (P. 87).

From a study of his book it appears that it is the following things in Mahatma Gandhi that have helped Mr. George to "realize Christ and his message." (1) He was living out the Christian ideal and showing how Christ's *Sermon on the Mount* can be practical politics. (2) His method of *satyagraha* is simply Christ's non-violent resistance of evil; and Mr. George thinks that Gandhi has brought Christ's "way of suffering love" to a science of mass-action by which revolutionary attack might be made upon

injustice and wrong. (3) Isaiah's picture of the Suffering Servant of God finds fulfilment in Gandhi just as it did in Christ. (4) By deliberately going out to face danger by bringing moral pressure to bear upon persons who are thought to be acting in an unjust or evil way, Gandhi showed the "potency and practicability of the method of the Cross"—a method that Mr. George declares to be more effective in the conquest of evil than mere preaching and propaganda. (5) Life as Christ lived it and as he wants mankind to live always costs, because life according to the will of God inevitably runs counter to many established practices and customs: Gandhi's acceptance and interpretation of suffering illuminates this principle. (6) Gandhi's assimilation of Christ's emphasis upon ethics while at the same time holding to the primacy of God, or, in other words, Gandhi's adoption of the "creative activism of the West" combined with the insistence that "the primary goal of all his efforts is God-realization." (7) Gandhi's belief that religion is a revolutionary force, experimenting with Truth, believing that Truth is God, and that it is not a matter of doctrine only but of action illuminated by the inner Light and effective for the attainment of God's Kingdom on earth. (8) Gandhi's confidence that "good and not evil is the foundation and meaning of life," that love is therefore omnipotent and that righteousness has the cosmic backing. (9) Gandhi's attempt to permeate all life (including politics) with the spirit of religion; this is the concept of the Kingdom of God or Rama Raj—not the brave new world of secularist science nor yet the falsely spiritual escape to a heaven beyond or an inner mysticism.

Mr. George's thesis is that Gandhi's attitudes and conduct constitute a challenge to Christians because he has put into practice the essential practical conclusions of the Christian faith. And so far there will be wide general agreement with Mr. George's conviction, though there may be differences here and there on specific points. Consequently there will be a general readiness to acknowledge Gandhi as a great servant of God, a mighty prophet of the things of the Spirit and a doughty Worker for the advance of God's Kingdom on earth. Across the barriers of tradition and creed that superficially may separate us "deep calleth unto deep," we are aware of a oneness and recognise in him a great Helper, Inspirer and Comrade. His good and heroic life acts upon us like the power of prayer, stirring our conscience, widening and deepening our sympathies, and strengthening us for high endeavour.

As might be expected from the fact that Gandhi is felt to be a challenge to Christians by being so notably "Christian" while remaining a Hindu, the book touches upon the question of the relationship between the different religions. But in this regard while Mr. George certainly succeeds in being stimulating and suggestive, it cannot be said that the three leading ideas which he puts forward are intellectually satisfactory, however congenial they may be to the practical desire for immediate harmony. He suggests (1) that the different religions may be regarded as different modes in which the Eternal manifests itself; (2) that they may be regarded as different varieties of the way in which man realizes the one Eternal Reality; and (3) that Christianity might be regarded as a special emphasis within the wider setting of Hinduism—the special emphasis being the moral holiness of God and the demand for such holiness on the part of mankind. While we may agree that these three ideas delineate what has actually been taking place in the temporal process of religious experience and thought, the question of *truth* remains at issue. There is a standard of adequacy or satisfactoriness which we call truth in which alone the mind can find rest. Truth in the sphere of religion is a much more complex affair and much more difficult of formulation than in the case of the natural sciences, but nevertheless its demands are as exacting and as imperative. It is in the light of truth that the relationship between the different religions must ultimately be sought. The aim of all religions is the same—"from the unreal lead me to the real; from darkness lead me into light; from death lead me to immortality"—but that is not to say that their achievement is the same.

It is good that Mr. George has raised this question of the relationship of the religions in his challenging and sincere way. The question calls for deep and sympathetic study in these days of the intermingling of peoples and cultures; and an important part of the study should be directed towards answering the question: What is truth? Is it correspondence of idea with outer fact or reality? Is it logical coherence with the whole system of experience which constitutes the universe? Or what? We are grateful to Mr. George for the way in which he has brought home to us the spiritual challenge of Gandhi's career and we hope he will some day give us a full study of those wider issues in connection with the relationship of the religions which he has so interestingly touched upon.

—JAMES KELLOCK.

Bhagavad Gītā and Modern Life, by K. M. Munshi. Bharatiya Vidya Bhavan Publication, 1947. Demy 8vo, pages 232. Price Rs. 6-0-0.

THE Gītā has been an eternal source of inspiration and guidance for all men of thought and action for all the centuries since it came to be written. In our times particularly, Swami Vivekānanda, Lokamānya Tilak and Yogi Arvind Ghosh among many others have written on the teachings of the Gītā, as expounding their outlook of life in the main. It is, of course, the very broad outlook of those teachings that tempts people of different shades of opinion, social as well as philosophical to comment on them.

Mr. Munshi's book is one other such attempt to understand and interpret the teachings of the Gītā from the point of view of modern life. His approach to the subject as he explains in the Foreword is in the light of the teachings of yoga and there too not technically or scientifically so but essentially based on individualistic experience.

The book contains seven lectures, six of which are particularly based on the teachings of the Gītā as very apt quotations given to substantiate the statements would show. In the beginning, historical and social background of the Gītā is discussed and here the author has pointed out how the ideals of the Gītā were shaped by the circumstances under which, it came to be written. Arjuna is very rightly pointed out as essentially a man of the world, groping in the darkness of confusion of thought and anxious to receive the right instruction. Yoga in its broader aspect, being the ideal kept before him, Mr. Munshi illustrates it by descriptions of the lives of thinkers from the east as well as of the west (lecture 3).

The fourth lecture lays emphasis on the nature of an individual on which one's emancipation depends. The various factors that go to determine this aspect of a man's life have also been adequately referred to and discussed. In the fifth lecture, the author gives a very vigorous defence of the system of "cāturvarṇya" as the Gītā conceives it. Superficial thinking has misled many a writer to denounce the system as such believing it to be the main cause of the miserable condition of the Hindu Society as it is commonly and erroneously done. Mr. Munshi has however rightly pointed out how the debacle was due to quite different causes (pp. 93-98), cāturvarṇya having nothing to do with it.

Very illuminating and instructive is the portion dealing with the working of the ideas of the Gītā during the historical period from the beginning of the Inscription period to modern times. The historical survey is both accurate and convincing. In the sixth lecture, certain practical aspects of the problem of the attainment of perfection in action are discussed and in the light of personal experience, the results are stated. As practical hints, they will be found useful.

The last lecture is really speaking not very much connected with the trend of general discussion in the previous chapters. Even though the conclusion drawn therein would appear to be indicated by the Gītā (=Dharmāvīruddho Kāmosmi Bhuteṣu Bharatar-ṣabha"), the entire discussion not being based on the teachings of the Gītā does not appear quite suitable in the context of the previous lectures. As an independent thesis, it is quite a thought-provoking view that the author has put forth. The conclusions are based on the theories of Yoga and are illustrated by experiences of the author himself and as such make quite an interesting and illuminating reading.

Mr. Munshi still promises to write more about the Gītā and quite naturally. There is no end to human experiences particularly in the life of a man like him. It will be watched and read with interest how his varied experiences are guided and corroborated by the teachings of the Gītā.

—K. R. POTDAR

Unmatta-Rāghava of Virūpākṣadeva, edited by Vyākaraṇa-śiromaṇi V. Krishnamacharya. Aiyar Library Series No. 57, 1946. Pages xii+28. Price Rs. 1-12-0.

THIS is a One Act Play of the type called Prekṣānaka composed by Virūpākṣadeva of Vijayanagara, who has shown his dramatic insight to some extent by altering the story in the Rāmāyaṇa and making Lakṣmaṇa, with the help of the Vānaras, recover Sītā by slaying Rāvaṇa and his people in war, and thus bringing the *unmatta* condition of Rāma to an end by his re-union with Sītā thus rescued by Lakṣmaṇa. He has rightly avoided the supernatural element which has been resorted to by Bhāskara-kavi in his *prekṣānaka* of this very name as can be seen from the Sanskrit introduction to this edition. The play must have been composed by Virūpākṣadeva considerably after his conquest of Ceylon in 1395 A. D. and perhaps immediately after his accession in 1404 A.D. as can be inferred from stanzas 3 and 97 where he is called *rājā* and *samraj* respectively, and also from the prose speech of the Sūtradhāra on the second page.

Considerable, indeed, are the difficulties of editing a text with the aid of a single manuscript ; and in such attempts defects are but quite natural. This accounts for the defects to be found in stanzas 24, 35, 54 and 75. The defect in stanza 35 can be set right by reading 'Nivasatīyetaṇ' instead of 'Nivasatīyetaṇ' which looks more like a misprint. Occurrence of *doṣas* like *yati-bhaṭṭa* in several stanzas, however, shows the weakness of the author only. In spite of a few misprints, which can be easily corrected, the editor deserves credit for having given the Sanskrit-loving public a good edition of this charming little play with an enlightening introduction in Sanskrit.

—G. V. D.

Sphoṭa-vāda of Nāgeśa Bhaṭṭa, edited by Vyākaraṇaśiromaṇi V. Krishnamacharya with his own Sanskrit commentary, *Subodhinī*. Adyar Library Series, No. 55. 1946. Pages x+31+114. Price Rs. 3-12-0.

LOVERS of Sanskrit in general and students of Sanskrit grammar and allied sciences in particular have been laid under deep obligations by Pandit V. Krishnamacharya and the Director of the Adyar Library Series by bringing out a good edition of the *Sphoṭa-vāda* in which the author Nāgeśa has dealt with the *sphoṭa* theory in its pros and cons. The obligations of the editor are all the deeper not only because he has given us a lucid explanation of the text in his learned commentary, but also because he has written a highly valuable introduction in Sanskrit discussing therein the phenomenon of the perception of *artha* from *śabda* according to different schools, and showing ultimately why the grammarians accept the *sphoṭa-vāda*. He has also further shown how it has been accepted by grammarians ancient and modern ; and discussed the nature and sub-varieties thereof. In the end he has given us some information about Nāgeśa Bhaṭṭa, his date and some of his important works ; and stated some special features of the work under review which make it superior to several other works on the subject.

—G. V. D.

Vedabhāṣya-sāra of Bhaṭṭoji Dikṣita, edited by Pandit R. N. Patankar, with an Introduction by Prof. F. K. Gode. Bharatiya Vidya Series, No. 12, 1947. Pages 25. Price Re. 1-0-0.

THIS little book of 25 pages is sure to intrigue the students of the *R̥gveda* in particular as it brings to light for the first time an attempt on the part of the famous grammarian Bhaṭṭoji Liṅgita to explain in brief the verses from that *Veda*. Professedly the author is only giving us the gist of the voluminous *Lhāṣya* of Sāyanācārya. A perusal of the portion that is made available in these pages, however, shows that after giving the sense of all the words in the verses, Bhaṭṭoji has discussed almost every word from grammatical point of view quoting the authorities of Aṣṭādhyāyī, Pīṭāśākhya, Nirukta and others. These quotations are, however, left untraced.

The work as it is published contains the commentary on the *first six sūktas* only of the first Maṇḍala, though from the introductory verse 3 it would appear that Bhaṭṭoji had commented on a portion much beyond the first adhyāya of the first aṣṭaka. This work, if recovered in full, is sure to be of a great interest to the Vedic scholar ; and as such deserves a strenuous search.

Prof. Gode's Introduction to this edition, like all his other writings, is precise and to the point, and is mainly historical in its outlook.

—G. V. D.

R̥gveda-Vyākhyā Mādhavakṛtā, Part II (Aṣṭaka I, Adhyāyas V-VIII), edited by Dr. C. Kunjan Raja, Head of the Department of Sanskrit, University of Madras. Adyar Library Series, No. 61, 1947. Pages viii+473-817. Price Rs. 15-0-0.

THE present volume brings to light the remaining portion of the very rare commentary on the *R̥gveda* by Mādhava, the earlier portion being published as early as 1939 as No. 22 of this very Series. Our deepest thanks are due to Dr. Raja who has, with strenuous efforts, put before the student of the *R̥gveda* a critical edition of the full text of Mādhava's commentary as far as it is available. The value of this commentary lies not only in its being pre-Sāyaṇa, but in its being based on some authorities like Yāska's *Nirukta* and also various Brāhmaṇas. He also refers to some other interpretations of words and verses and discards them as being *apramāṇa* if they

are not backed by any authorities. He also discusses the various grammatical peculiarities, particularly the accent and has referred to five other works of his viz., the *anukramaṇis* of samaya, itihāsa, chandas, vibhakti, and svara. Nor is he ashamed to own his inability to understand a particular point. In such cases and also in other cases where there is any difference of opinion he declares that the matter should be learnt from the *bahurūtaḥ*. From a reference on page 735 it is clear that several commentaries must have been composed on the R̥gveda before Mādhava and that they must have been available to him.

The present edition is based on the only available MS. in the Adyar Library ; and must have taxed the energies of the indefatigable editor to a great extent, indeed. For it must be admitted that on the whole the work of editing has been very ably done as can be seen by even a casual glance through these pages and the foot-notes on them. But in a laborious work of this type it is but natural that some errors both of commission as well as of omission should creep in, in spite of all the care bestowed on it by the learned editor. Of misprints there are only a few ; but they can be easily understood and hence need not be considered here. We might refer to a few instances where the original text has been printed as it is with the remark in the foot-note to the effect that the portion cannot be properly understood. Thus we might suggest that we might read (i) *śvetam adhārayaḥ* p.478, (ii) *himsārthaś cobhnātiḥ* p.483, (iii) *pārthivasya rajasah* p.493, (iv) *viṣṭhitāni* p.609, (v) *sutejasam* p.645, (vi) *tasmin nibālhaḥ patita iti* p. 706 where *patitaḥ* is the paraphrase of *nibālhaḥ*, and (vii) *sunvatīnām ante*, p.750 where *ante* is the paraphrase of *udarke*. Two more cases of this variety may further be discussed. One of these occurs on page 661 where the commentator is discussing cases of *sūktas* with more *ṛsis* than one. He has stated the general rule that in such cases one of the *ṛsis* is the main *draṣṭā* of the hymn, while the rest are only the *protśūhaka* or assistants. Thus in the *sūkta* under consideration *ṛjṛāśva* is the main *ṛsi* as can be seen from the 17th verse. In VIII. 71 the main *ṛsi* is *Purumīlha*, and as for *Ajamīlha*, it is stated by Śātyāyanaka that he only asked Purumīlha to recite the *sūkta* with the word *stuhī*. In the light of this explanation we may now read the passage in question as follows :—“*Ajamīlhaś tu purumīlham stuhīti cāvad uvāceti śātyāyanakoktam iti.*”

The other case occurs on page 496 where introducing the 65th hymn the commentator says that six hymns from there are in the *dvīpadā virāj* metre. But generally, he remarks, we take two such verses as forming one and that if after counting like this only one verse is left at the end, that verse is to be taken as a separate *ṛk*. Bearing this point in mind we may now emend the passage in question as follows :—“*Dvaipadāni ṣaṭ sūktāni/Tatra dve dve ṛcau loke ekaikām samāmanāmo, yukṣv antyām ekām ekām eva.*”

There are some cases where the suggested emendation does not appear to be quite happy ; and one would like to hunt for a better and more suitable emendation if possible. Thus *Kṣapah* p. 491, *Diptarṣṭayaḥ* p. 493, *Karmāsevanta* p. 507, *Padamasyanti* p. 576, *Vyundanti* p. 581, *Prayacchantu* p. 605, and *Preritavān iti* p. 616 will be found to be more appropriate and supported by the text.

We may further point out some cases where the original reading as found in the MS. needs no emendation though emendations have been suggested, or the same in the foot-notes. Thus *Paricaranty angulayaḥ indram* p.478, and *Diśah stutayo deṣṭavyāḥ* p. 497 can be explained as they stand ; and need no emendation whatever.

But as we have already stated above such errors here and there are bound to occur in a work of this type and need not be taken as detracting from the value of the work itself or the vast amount of labour that an editor has to bestow before he can bring out a valuable edition of any important work, particularly when he has to depend on a single MS. We most heartily congratulate Dr. Raja on the high standard that he has maintained in this edition by laying before the reader a thorough picture of the original MS. in the text and the foot-notes, and also suggesting in the foot-notes whatever emendations and remarks he has to make with regard to the reading as found there. We are now eagerly looking forth to the last Volume promised by Dr. Raja containing his critical introduction which is sure to be highly instructive and interesting to the student of the R̥gveda in particular on account of the light it is expected to throw on the various topics arising out of the discovery of this important commentator and his highly valuable commentary.

The book is nicely printed and bound in cloth ; and well deserves a place in any library as an important aid to the study of the R̥gveda.

—G. V. D.

Marathi Etymological Dictionary (Historical and Comparative), compiled by Prof. K. P. Kulkarni, M.A., B.T., Professor of Marathi, Elphinstone College, Bombay. Published by Keshav Bhikaji Dhawale, Bombay 2. Pages 120+780. Price Rs. 22-0-0.

THESE 800 pages are the outcome of the ripe labours of Prof. Kulkarni for several years and form the *M. R. Jaykar Prize work*. Our thanks are due to the authorities, of the 23rd *Maharashtra Sahitya Sammelan* for entrusting this work to Prof. Kulkarni who had already proved his capacities for a work of this type by completing the *Dhātukośa* on behalf of the *Rajvade Samśodhana Mandir* in 1937.

The scholarly Introduction of 120 pages discussing in details several points in philological studies forms a special feature of this work. Prof. Kulkarni has therein given almost everything that a general student of philology should know ; and has given it all in a very lucid manner.

The remaining 780 pages form the main bulk of this dictionary wherein Prof. Kulkarni has, as far as possible, tried to give a historical and comparative study of Marathi words. He has given for comparison words not only from Sanskrit, Prakrits and current Indian languages, but also from European languages ancient and modern. Any student of philology and of Marathi in particular will feel highly indebted to Prof. Kulkarni for bringing so much material together and presenting it in a scholarly manner.

It must, however, be admitted that several words have escaped the notice of Prof. Kulkarni ; and a student is disappointed to find that this dictionary omits altogether several words like नितळ, मळम (मळमट), छाकटा, and भसूर. Even in the case of words included and explained in these pages, it is not always easy to agree with Prof. Kulkarni in the etymology or explanation offered by him.

Thus it is impossible to accept Prof. Kulkarni's derivation of (i) विवर (ण) from reduplicated √वृ (p.664), (ii) रायवळ as अरण्य > रण > रान + आवलि or वळा. (p.616) and (iii) his remark on अप्रस्तुत (p.6). विवर (ण) must be derived from the root वृ with the preposition वि ; for without the preposition the root means merely "to cover" which is just the opposite of the sense conveyed by the word विवर (ण). रायवळ does not in the least contain the idea of forest (अरण्य). It means ordinary (mangoes) i.e. growing in natural course in an orchard as opposed to specially grafted ones like the हापूष. The word must, therefore, be derived from राज > राई (=आंबराई) with the addition of the suffix वळ in the sense of "belonging to, coming from." अप्रस्तुत literally means "what is not begun, i.e. irrelevant," so that there is hardly any change in the sense of the word as used in Sanskrit and as used in Marathi.

In the case of words like खेडवळ and भल्या (in expressions like भल्या पहाटे) better suggestions may be made. Thus the former may better be derived from खेड (cf. खेडे in Marathi) with the addition of वळ. This derivation is certainly more appropriate than the two suggested by Prof. Kulkarni, if we take into consideration the sense conveyed by the word खेडवळ. Similarly भल्या can more easily and naturally be connected with the Pk. बले which according to Hemacandra conveys the idea of निर्धारण or निश्चय. The word भला-ला-ले in Marathi also is used to emphasize the idea conveyed by the word following it. (cf. भला मोठा, भला भक्कम, भला जाड, etc.) Its derivation from प्रभात is only too far-fetched.

Not can we agree with Prof. Kulkarni when he declares that one sense of the word अवच्य is quite in keeping with the Sanskrit root underlying it, while the other sense it has got only under the influence of the word अवच्य. But it may be pointed out that, वाच्य in Sanskrit has both the senses, so that there should be no difficulty in having both the senses of अवच्य from the original Sanskrit only.

In spite of all such shortcomings Prof. Kulkarni deserves our heartiest congratulations for having compiled this valuable dictionary, which, we feel sure, will give a stimulus to philological studies with reference to Marathi in particular.

We also congratulate Messers Keshav Bhikaji Dhawale on the high standard of the general get-up and printing maintained in this work.

—G. V. D.

Drama in Sanskrit Literature, by Prof. R. V. Jagirdar, M.A. (London), Karnatak College, Dharwar. Popular Book Depot, Bombay 7, 1947. Pages vii+167. Price Rs. 8-4-0.

THIS is a startling little work in which Prof. Jagirdar has stated and to some extent tried to justify his views regarding the origin and development of Sanskrit Drama, by "a close examination of the growth of dramatic technique." Naturally, therefore, has he left the "vexed question" of chronology in Sanskrit Drama out of consideration though he has his own views thereon which he has adhered to in the present work."

Prof. Jagirdar deserves credit for striking a new line of thought altogether in the studies of Sanskrit dramatic literature and boldly putting forth his own findings some of which, he is sure, "will offend the orthodox critic." The present volume, however, does not claim to be "either complete or satisfactory;" and the learned author intends "to bring the story of the Indian stage unto the modern times" by another volume. We expect that some of the problems raised by the present volume will find better light and elucidation in the promised volume.

It must, however, be stated here that Prof. Jagirdar's work would have carried greater conviction if he had cared to state even the rival or orthodox views (as he calls them) and examine their validity in the light of his own findings. Thus, for example, his view about the authorship of the thirteen plays generally ascribed to Bhāsa may not be found acceptable unless the rival and the more generally accepted view on the point is fully refuted. Again the view about the Interlude in both the varieties will have to be substantiated by a still closer and more careful scrutiny of all the Interludes available in classical Sanskrit dramatic works, and also the information about the same in the known works on Sanskrit dramaturgy. On the whole one feels that the work though putting forth some bold theories is yet rather wanting in details which in fact should form a greater bulk in works professing to strike a new path.

We heartily congratulate Prof. Jagirdar for having brought out a work which will be read with great interest and profit by every one interested in the study of Sanskrit drama, particularly because it is sure to supply him with several new ideas and problems and make him think.

The book is nicely printed and strongly bound in cloth with a paper wrapper; but the price appears to be rather too high.

G. V. D.

Suvarṇasaptatiśāstra (Sāṅkhyakārikā Saptati) of Īśvarakṛṣṇa, with a Commentary (reconstructed into Sanskrit from the Chinese translation of *Paramārtha*), edited with English Notes, Introduction and Appendices by N. Aiyaswami Sastri, with a Foreword by Prof. P. P. Subrahmanya Sastri, B.A. (Oxon.), M.A. (Madras). Sri Venkatesvara Oriental Series, No. 7, 1944. Pp. xvi+112. Price Rs. 6-0-0.

THE *Suvarṇasaptatiśāstra* better known as the *Sāṅkhyakārikā* generally ascribed to Īśvarakṛṣṇa is the oldest extant systematic exposition of the Sāṅkhya system. Besides the commentaries of Gauḍapāda and Vācatimiśra, there is a third commentary called the *Māthara-vṛtti* discovered about three decades ago which was suspected to be the original of the commentary translated into Chinese by *Paramārtha*. But after a very close and careful comparison of the contents of all these commentaries it is now proved that Gauḍapāda's commentary is based on the original of *Paramārtha* which in its turn was based on the *Mātharabhāṣya* mentioned in Jain works, which however, is quite different from the *Mātharavṛtti* or *Mātharaprānta* as it is otherwise called by Guṇaratna.

The very name of the work settles the problem of the extent of the work as comprising seventy verses only ; and the commentary included in the present edition goes a long way to fix up the actual verses. The date of the commentator can be proved from the fact that it was translated into Chinese in 557-569 A.D. and that the treatment of the anumāna as found in the present commentary is more crude and hence earlier than that found in the Nyāya-sūtra Bhāṣya of Vātsyāyana. The commentary is, therefore, assigned to about 350 A.D. which is quite in consonance with the date of Śvara-kṛṣṇa (c. 300) who is said to be an older contemporary of Vasubandhu (c. 320).

The learned editor has dealt with these and several other problems concerning the Sāṅkhya-kārikā and the commentary published here in a scholarly introduction. It is a matter for regret that several misprints have crept into this otherwise very ably edited work. Students of Indian Philosophy have every reason to thank Aiyaswami Sastri for reconstructing this earliest and most valuable commentary on the Sāṅkhya-kārikā from the Chinese translation of Paramārtha and making it available to them.

—G. V. D.

Descriptive Catalogue of Sanskrit Manuscripts in the Adyar Library, Vol. VI—Grammar, Prosody and Lexicography, prepared by Pāṇḍit V. Krishnamacharya, under the supervision of Dr. C. Kunhan Raja. Adyar Library Series, No. 60, 1947. Pages xxxii + 451 + iv. Price Rs. 25-0-0.

THOUGH sixth in the scheme, the present volume is really the second to be published, the first (which is the first in the scheme also) being already published as far back as 1942. Whereas the first volume dealt with the Vedic Manuscripts in the Adyar Library, the present one describes the Vyākaraṇa, Chandas and Kośa manuscripts. Out of the 1,037 MSS. described in this Volume, 746 belong to Vyākaraṇa, 48 to Chandas and the remaining 243 to lexicography. The grammar manuscripts have been arranged into three groups, Paninian, non-Paninian, and Prakrit including Telugu. The MSS. have been ably described and ample extracts have been given. The compiler has also given information about the author and the work contained in the MSS. under description.

It was believed upto now that Bhaṭṭoji's Śabdakaustubha went only as far as the fifth āhnikā of the third chapter ; but the present catalogue reveals that it must have gone at least upto the end of the fourth chapter. The Kavikalpadruma described under No. 434 would better have been included in the Non-Paninian Manuscripts. The author of the Vṛtta-dyumaṇi described under No. 752 is Yaśavanta Gaṅgādhara Candracūḍa, the son of Gaṅgādhara Yaśavanta Candracūḍa who worked as *divan* of Malhar Rao Holkar for several years. From his own statement we know that he composed the Vṛtta-dyumaṇi in Śaka 1697 at a place known as Pāribhadra situated on the bank of the river Bhīmā. The name of the author of the Vāṇibhūṣaṇa in the printed edition appears as Dīrghaghoṣa and not Dīrghayoṣa as is found in this Catalogue under No. 751. Similarly it is stated there that this work is profusely quoted by Lakṣmīnātha in his commentary on the Pāṇḍit Pingalāsūtra composed in 1600 A.D. This would show that Dāmodara must be placed at least a few decades before that date. As for Mahādeva Vedāntin there can be no doubt that he composed his commentary on the Viṣṇu-sahasra-nāma in 1664 A.D. which evidently shows that the date fixed by Garbe cannot be accepted.

In spite of some deficiencies and inaccuracies of the nature mentioned above that have crept into this volume, it must be admitted that the MSS. have been ably described ; and good information has been brought together along with relevant quotations.

The Introduction from the pen of Dr. Raja may be said to form a special feature of the work under review. In it he has given a brief survey of the grammatical literature in Sanskrit and shown the importance of grammatical studies even to-day. We sincerely and heartily congratulate Dr. Raja and the learned compiler of the present Volume and look forward to similar Volumes bringing to light important MSS. and useful information in other branches of Sanskrit literature.

—G. V. D.

Rao Bahadur Dadoba Pandurang,* by Prof. A. K. Priolkar. Published by Kesava Bhikaji Dhavale, Bombay 4. First Edition, 1947. Price Rs. 12-0-0.

THE raw materials for biographies are in general letters or diaries, eulogies or historical annals or brief biographical notices in contemporary periodicals. The value of biographies depends on the amount of light they are able to throw on the development of more formal, more conscious or more complete records of human careers. For this purpose the historical method can be applied to the subject matter as a means of exacting facts. The historian applies the historical method to documents that have survived from the past and collects his data. These are then employed by him to reconstruct pictures of past personalities or past cultures by following an exacting scientific method of not taking anything for granted and not allowing one's own imagination to run in subjective speculation. For a scholarly historian of culture or literature history means mainly (a) process of examining records and survivals and (b) presentation of the results of that examination in a reconstructed form without doing violence to the records in a lucid and logical way.

These canons generally apply to the book under review. To make a book of scholarship of this kind both readable and authoritative is an achievement in itself and we congratulate the author on this.

This book in Marathi consists mainly of 3 parts— a critical essay on "Autobiography, Biography, and Memoirs" by Prof. R. K. Lagu (33 pages)— Autobiography of Dadoba Pandurang edited by Mr. Priolkar (200 pages) and the addendum to the autobiography completed by the author, Mr. Priolkar, into a biographical account of Dadoba Pandurang (261 pages). There is also a foreword by the Hon'ble Shree B. G. Kher, Prime Minister, Bombay (4 pages) and an account of the writing of this book by the author (17 pages).

The essay by Prof. Lagu is in no way connected with the work of Mr. Priolkar but gives a good historical background to the subject of writing of autobiographies and biographies in general and in Marathi language in particular. The work of Mr. Priolkar would not have been less scholarly without this essay. The account of the author about the work is very interesting particularly because of the pains he has taken to sift evidence and do the research regarding the manuscript of the autobiography and the material he has collected for the biography. The book is wanting in one important feature and that is an exhaustive bibliography of the primary and secondary material used by the author. He has been apologetic about it (page 56) and his fear was want of space. Some of the references are mentioned in the foot-notes and the abbreviations of some of the documents used by the author have been given on page 56. However, for any such scholarly book an exhaustive bibliography is indispensable and it is hoped that this improvement will be made by the author in the second edition. The work will also gain in its usefulness by an addition of a page or two giving dates and important events in the life of Dadoba Pandurang.

This work has mainly three aspects : (i) editing of the autobiography—a scholarly piece of work (ii) taking up the thread of the autobiography and completing it as a biography—a very interesting piece of literary writing and information (iii) historical significance of the work throwing so much light on the life of the people particularly in Bombay and Maharashtra during the first years of British rule in India in the 19th Century.

At the outset a word may be said about the presentation of material in the work. The author has succeeded in creating an atmosphere of the early 19th Century social and political life of the people and sustaining the interest of the reader throughout his account in the biography. This was no mean task when he had to write it as a conclusion to an autobiography, which in itself, is a very interesting document for all students of the period.

Dadoba Pandurang was born in Bombay on 9th May, 1814 and his autobiography has been brought up to the year 1848. The biographical account is given for the rest of his life upto 1882. Thus the period nearly covers the whole span of the 19th Century. The author has given in brief the period during which the autobiography was written

*This book was awarded the R. B. Dadoba Pandurang Tarkhadar Prize of the Bombay University as the best book in Marathi of the year 1947-48.—*Editor*.

(pages 44 and 45) from which it is clear that the autobiography was begun in the year 1868 and was left incomplete in the year 1882. The story of the manuscript described by the author (pages 42 to 44) is unusually interesting and reveals the general condition of valuable manuscripts and records in our country.

The hero of the book is not a great historical character but every school boy has heard his name as the first writer of a text-book of Marathi Grammar. There is nothing dramatic, romantic or exhilarating in the character of the hero. He has no political secrets to divulge nor strong personal animosities to express. The conscious analysis of the ingredients which enter into life writing is perhaps lacking here. But here is a picture of the common man of the 19th Century from the cradle to his grave—of one who felt and thought intensely and in a limited sphere of life held high social and moral values. Mr. Priolkar has successfully applied his critical theory in painting consistently the character of the man in the second part in conformity with his self-depicted character in the first.

The autobiography edited by Mr. Priolkar is in itself a piece of scholarly work, particularly because of the foot-notes and explanations offered. These throw light on the language of the time, the social conditions and the various publications with which the hero had his contact. Points of grammar and philology as well as obscure words have been explained by the editor. Cross references from other works have been given to explain points which may not be clear to the reader. These 200 pages are valuable in themselves to a student of literary and social history. The significance could have been enhanced if philological and grammatical notes could have been a little more exhaustive, and fuller extracts from the documents of reference had been given; for this is surely a store-house for research students and apart from what the author wanted to do—writing about orthography which certainly can be done even now, these 200 pages, as edited by Mr. Priolkar, are a source book for research workers in the field of social and political history as well as literary history of the period.

The latter half of the book, which is a biography written by the author, opens new vistas into many historical, social and political controversies. The author, it must be said, has set about settling a good many of these by giving necessary evidence but every time one feels that more information and more light on the problems he has touched upon would have made the students of the period very grateful to him.

Dadoba Pandurang is the first grammarian in Marathi language and the chapter about various editions of his grammar and his works throws a great deal of light on the early history of the writing of Marathi grammars. The author even touches upon religion, social reforms, political problems, the rule of the British, education, schools, etc. It is these subjects that need further research and the author has rightly shown the line for such research: the old newspapers, the old records, the government gazettes and the periodical literature of the time—these have been gone through with great patience and the author has given us a connected story out of this data. The extracts given from the *Bombay Gazette* of the year 1841 (pages 385 to 393) tell us about the British rule of the time and the protest that was started by some of our men even more than a hundred years ago at the very beginning of the British rule.

The value of this book can be considered particularly from one point of view and that is the new attempt made by the author at scholarly work of research through old records. This type of work is being done, for example, for English literature in the British and American Universities. But our Universities are taking up this line of research now and Mr. Priolkar has done creditable performance. The tremendous amount of work that has been done in the case of research into periodical literature in English can hardly be compared with any work done with reference to Indian languages. This is partly due to the fact of paucity of material available and paucity of properly indexed records. However, the energy that is being brought to bear on the subject by the Department of Archives of the Bombay Government and of the Government of India will bring forth good many opportunities for scholars and students to explore into the dark past with the scientific spade of the academician and the lines of such a work have been suggested by Mr. Priolkar. This book, therefore, deserves high commendation.

Doutrina Cristã—em Lingua Concani por Tomas Estevão, edited by Professor Mariano Saldanha. Agencia Geral das Colonias, Lisboa, 1945. Pages 268.

PROFESSOR DR. MARIANO SALDANHA of the Lisbon University deserves to be congratulated on bringing out a second edition of the *Doutrina Cristã* by Fr. Thomas Stephens, of which the first edition was published in Goa in 1622. This second edition contains, besides a facsimile reproduction of the first edition, a masterly introduction by Professor Saldanha, as well as critical notes, a Glossary and Bibliography relating to the author and his work, all written in Portuguese.

Father Thomas Stephens (1549-1619), the author of the *Doutrina Cristã*, came to India in 1579 and was the first Englishman to have visited India. His letters from India to his father are said to have helped in bringing about the incorporation of the East India Company. The *Doutrina Cristã* is a religious work in the form of a dialogue between a *Guru* and his *Shishya*, written in the spoken idiom of Goa. The language is referred to in the book as "Lingoa Bramana Canarim." The aim of the book was to indoctrinate the converts to Christianity from Hinduism into the tenets of their new faith. In addition to the *Doutrina*, Fr. Stephens prepared a grammar of the spoken language of Goa, under the title "Arte de Lingoa Canarim." This book after being revised and enlarged by four priests of the Society of Jesus, was printed in 1640 at the College of St. Ignatius at Rachol (Goa). Fr. Stephens' *magnum opus*, however, is the *Christian Purāṇa*, a poem composed in Marathi, the literary language of Goa. This work was printed and published in 1616, during the lifetime of its author. In the introductory chapter of the *Christian Purāṇa*, we find reference to the *Doutrina*, and to the conditions under which it had to be supplemented by the *Christian Purāṇa* in Marathi. The *Purāṇa* was written at the special request of the Brahmin converts of Salcette, who were experiencing a vacuum in their religious lives owing to there being no adequate Christian literature to replace the classical Hindu *Purāṇas* in Marathi of which they had been deprived :

Zi Zi hy doutrini harauy niqy
Carauissy pattha hiye loquĩ
Deaueya parama vollaqhy
Paramesuarachy (131)

Panna he doutriny vanchoni ana
Cahĩ yeca agallem xastra Puranna
Zari ama carauite patthana
Tari honte changa (134)

Ha motta abhiprauo zi mhanne
Tumĩ tari varilĩ maguilĩ puranne
Tari pratipustaque ama caranne
Caissĩ nacarity tumĩ (143)

Ya passoniya zi atã
Gentiyanchea puranna catha
Nauca Christauanchea chita
Athauaty deqha (144)

Zari Maratthiye bhassechĩ cahĩ
Xastra Puranne hontĩ amã tthaĩ
Tari locacha manorathu paĩ
Purna honta (145)

At present, the *Doutrina Cristã* is a work of immense value to a wider public than the Indian Christians on account of its language. Under the pressure of the circumstances of modern life and with wider spread of the knowledge of the literary languages the dialects are at present rapidly going out of use and undergoing rapid transformation. In the present work we find preserved the form of the dialect spoken by the Brahmins of Salcette in Goa about 350 years ago and this makes very instructive comparison with the present form of the same dialect. At present the dialect is popularly known as Konkani and Dr. Saldanha uses this name on the title page. It is interesting to remember however that this name is of comparatively recent origin ; in fact it seems to derive not from the name of the place in the sense of the language spoken in Konkarn, as is currently believed, but rather from the name of the community speaking it, Konkarni being the language spoken by the Konkarnes. The word Konkarn is much older and was

the term applied to non-Christians by the Christians since comparatively early times. Father Stephens uses the word in this sense in the work under review :

“Samesta concann[~]ale Deva, devadutā, anny tanchy
ritu parauaddi, achara, ghaddipanna, zoissipanna
uazunu, yecachi sateuanta paramesparaca manu deuncho—” (p. 130)

Apart from the name, the actual form of the idiom as it appears in this work bears close affinity to older forms of Marathi such as the language of Dnyāneshwari, and is comparatively far removed from the present day Konkani as spoken by the Goa Christians. In fact the language spoken by the Saraswats of South and North Kanara today provides a closer approximation to the language of the Doutrina Cristã. The work under review, which was deliberately written by its author in the spoken language of the contemporary Christian converts for their daily use, would be hardly intelligible to average Konkani speaking Goa Christian today. One way of realising the extent of the wide gap that separates Stephens' language from the modern Goa dialect, is to compare the work under review with a modern version of the Doutrina. I have before me a copy of the “Catechismo da Doutrina Cristã em Concanim,” prepared by “Presbiterio Francisco Antonio C. Nazare, Professor sido de Semanario de Damão,” and published by Tip: Rangel, Bastora (1938). In this book, the obvious object of making the Doutrina intelligible to the modern Goa Christian has necessitated such a variety of changes in language as well as other additions and omissions that it has been transformed almost beyond recognition.

Dr. Saldanha has indeed placed the students of modern Indian languages under a deep debt of gratitude by bringing out this very scholarly edition of the Doutrina Cristã. The Agencia Geral das Colonias of the Portugal Government also deserves our thanks for undertaking its publication. The price of the book is not stated. It is unfortunate that although the book was published in 1945, it is not so far available for sale even in Goa, where one would expect the value of Dr. Saldanha's labours to receive speedier recognition. It is to be hoped that such Universities in India as offer courses in the development of Marathi language and literature will show their appreciation of the value of Stephens' book and Dr. Saldanha's work in connection therewith by prescribing the Doutrina Cristã for critical comparative study at the appropriate level in their postgraduate programme.

—A. K. PRIOLKAR

Location of Laṅkā, by Sardar M. V. Kibe. Manohar Granthamala, Poona, 1947. Pages vii+62. Price Rs. 2-0-0.

LOCATION of Laṅkā is one of the most fascinating and elusive riddles of the *Rāmāyaṇa*, and in their attempts to solve it, scholars have found diverse and varied sites, some of which have been mentioned by Mr. Tikekar in his Introduction. It is indeed curious that the same data from the *Rāmāyaṇa* should afford such diverse and mutually contradictory conclusions. Besides these theories, some hold that the Laṅkā of the *Rāmāyaṇa* is but an imaginary fortress having no counterpart in actuality, while others interpret the story of the *Rāmāyaṇa* as an allegory.

Sardar Kibe, who first put forth his theory before twenty years, locates Laṅkā north of the Narmadā and Vindhya near Amarkantak in the Central Provinces. He has no doubt put a strong case, but has not attempted a complete refutation of the Ceylon theory, nor has he answered criticisms against his views (Cf. Bhandarkar, *Jha Comm. Vol.*): North of the Vindhya traditions relating to Rāvaṇa are associated with places in Jodhpur State as also in Bastar and Sonpur States in Orissa, and Laṅkā can as well be located in these territories following Sardar Kibe's interpretation. The main point for consideration is the identification of Godāvari and Vindhya, and the present reviewer considers that the *Rāmāyaṇa* references point to the river near Nasik, and that there was another Vindhya near the southern extremity of the peninsula (Cf. Pargiter, *JRAS*, 1894, p. 261).

The book deals with other topics besides the location of Laṅkā, such as the descendants of Rāvaṇa and the unhistoricity of the Uttarakāṇḍa. Here also the author does not fully consider the other side. However, the book evinces Sardar Kibe's deep study of the *Rāmāyaṇa* and allied literature, and will amply repay perusal.

—A. D. P.

Ācārya Dhruva Snānaka Grantha (*Acharya Dhruva Commemoration Volume*), Parts II and III, edited by Rasiklal C. Parikh and others. Gujarat Vidya Sabha (Gujarat Vernacular Society), Ahmedabad, 1946. Pages vi+190, vi+262, with plates. Price Rs. 8-0-0, each volume.

THE Gujarat Vidya Sabha deserves to be congratulated by scholars interested in Oriental learning for the varied and sumptuous fare in memory of the late Acharya Dr. A. B. Dhruva, "the last of the learned Brāhmanas of Gujarat," as Shri K.M. Munshi aptly said. The second part contains some appreciative articles about the learned *savant*, which throw a wonderful light on the different facets of his life and scholarship; there are also articles on general subjects. There are papers on Indological subjects in Part III. The total number of contributions in both the volumes, excluding personal reminiscences is about 40. It is not possible in this review to refer to all of them. We have drawn attention only to the important papers that interested us. The names of the writers evince the high respect in which Acharya Dhruva was held by scholars all over India.

In the second part, Dr. Amarnath Jha writes about Khwaja Mir Dard, an early Urdu poet, with quotations from his works. Principal A. K. Trivedi's article on "The Perfection that is Reality" shows that "it is not perfection in armaments that is Reality, but perfection in Spiritual Realization which is Reality and also Bliss." In a learned and thoughtful article entitled "A New Approach to Philosophy," Dr. N. B. Junnarkar states that the discovery and establishment of an appropriate philosophic method is the *sine qua non* of the solution of our present difficulties, and discusses the various aspects of social philosophy. Dr. S. V. Puntambekar deals with the "Relation of History and Sociology," and concludes that "we cannot subordinate history to sociology." In "Social Psychology of Language" Dr. P. H. Valavalkar discusses several theories regarding the origins of human speech, and shows language as a powerful socialising force. Dr. B. B. Chand's "Administrative Function" examines the combination of executive and judicial functions in India. With imaginative and psychological insight Miss Bharati Subhai reconstructs the relationship between Ernst Toller and Tessa on the basis of *Letters from Prison*. Prof. Gheewala's article shows that Dharma is the basis of the State, which exists in order to sustain and enforce Dharma, and is the sanction behind the authority of the king.

The third part opens with "The rooty Ven and its verbal forms in the Rgveda" by Dr. V. M. Apte, followed by an interesting article on the Kathopanishad by Dr. S. K. Mitra. There are three articles on the Bhagavadgītā: Dr. Belvalkar interprets afresh the Yajñacakra in III. 1-15; Dr. P. M. Modi discusses the central teaching of the Gītā and the harmony of its different Adhyāyas; Prof. Umashankar Joshi refers to the Secret of Supreme Harmony from the Gītā. Papers on Jainism are contributed by Dr. B. B. Chand and Mr. U. P. Shah, while Dr. B. Bhattacharyya writes on the sublime Mahāvāna. Paintings are dealt with by Dr. Majumdar and Mr. N. C. Mehta, while Dr. Katre and Prof. K. K. Sastri write on linguistics. Rao Bahadur K. N. Dikshit has an interesting and important note on the Archaeology of Gujarat, which alas! he could not live to see in print.

Special mention must be made of Dr. Chatterji's learned and thought-provoking paper, Jayadeva Kavi. Dr. Altekar concludes on epigraphical evidence that during the Gupta-Pallava period, the state and village community claimed ownership in waste, marshy and forest lands only, while all arable land belonged to private proprietors. Dr. Raja points out the great difference between the description of Aja in Canto II and that of Daśaratha in Canto IX of the *Raghuvamśa*, and incidentally hints that the latter canto does not seem to be the work of Kālidāsa. Dr. Raghavan has discussed the semantics of the expression "devānāmpriya." In his "Two Notes on the Origin of Sanskrit Drama," Prof. Mankad shows that the earliest Greek drama was a monologue; and that the *rāgas* and *phāgas* in *Apabhraṃśa* and old Gujarati represent the *Nritya* types described in the *Shāstraprakāśana* and other works. Mr. A. N. Krishnaswami Aiyangar deals with the authorship of *Rasārnavaśuddhakarā*, and other works of Singabhūpāla. Mr. Nārahari draws attention to a little known 18th century work on poetics named *Hamsamithu*. Among scientific literature, we find articles on the "Procession of the Equinoxes and its discovery in India" by Prof. Abhyankar, "Glimpses from the Ayurvedic Sāmhitas" by Dr. B. A. Pāthak, and "the rôle of Yava and Caṇaka in the regimen of Indian horses" by Prof. Gode.

The volumes with such articles on varied subjects by competent scholars will no doubt prove useful to all workers in Indology.

—A. D. P.

Śatakatraya of Bhartṛhari (The Southern Archtype): For the first time edited by D.D. Kosambi. Bhāratiya Vidyā Bhavana, Bombay, 1946. Price Rs. 5-8-0.

THIS is a carefully prepared critical edition of Bhartṛhari's Śatakatraya representing the main form of its southern tradition or recension. It is based on about 24 manuscripts divided into four groups in accordance with the script in which they are written, namely, Devanāgarī, Telugu, Grantha and Malayālam.

The learned author has collected and sifted his manuscript material and other evidence very patiently and methodically. The determination of the number and order of the stanzas in each of the three Śatakas, and particularly the fixation of the form of each stanza is indeed a very difficult task even when it is restricted to a single recension ; but it is creditably executed by Prof. Kosambi, following the best traditions of editorial integrity and aloofness.

All variants from the manuscripts are systematically noted under the text, after the commentary which by the bye, is by a southerner of not a very high antiquity. Further, what is more useful for the determination of the authorship of each individual stanza as well as the degree of its popularity, the different anthologies and other works where the stanza is quoted are mentioned with its exact location therein. When in the anthologies the authorship of the stanza is ascribed either to Bhartṛhari or to some one else, this is indicated within the brackets.

In short, this is an excellent piece of editorial work and we cherish strong hopes about its successor, namely, a comprehensive critical edition of the Śatakatraya, with a detailed inquiry into its authorship and other kindred problems.

—H. D. VELANKAR

Life in Ancient India : As Depicted in the Jain Canons, by J. C. Jain, M.A., Ph.D. New Book Company Limited, Bombay, 1947. Price Rs. 35-0-0.

THE book is an attempt to reconstruct life in Ancient India from allusions to contemporary men and events—mostly incidental—occurring in the Jain Agamas. The Jain Agamas are composed in a Prākṛta language called Ardhamāgadhī, which was derived from Sanskrit and which is supposed to have been spoken by the common people at the time when Mahāvīra preached his doctrines and faith. Naturally, the Agamas like the Buddhist scriptures, disclose an acquaintance with the same phases and characteristics of Culture and Civilization of the ancient Aryan Community, which are known from the study of the Sanskrit sources of the same period. The Jains and the Buddhists were part and parcel of the Aryan community and could not have any separate culture or civilization. They differed from others only in respect of their religious faith and behaviour as also their philosophical doctrines ; but certainly not in the degree of their civilization, nor in their notions about general morality, their social customs and beliefs, their knowledge of secular sciences like Medicine, Astronomy, Astrology, History and Geography, and Politics. So that a study of the Jain Agamas is not expected to throw much additional light on the general conditions of life in ancient India, but is expected mostly to confirm what is known from the Dharmasāstras, the Epics, the Purāṇas and the Kāvya, i.e., from the post-Upaniṣadic literature composed in Sanskrit. Yet, because Jainism in its earlier phases, mostly flourished among the trading classes and other strata of society which were not ridden with the Vedic ritual, the Jain Agamas are bound to be a fruitful source of information about the life of masses in general and of Jain Laity and Śrmanic order in particular, in ancient India. From this point of view, Prof. Jain's book admirably serves its purpose.

Prof. Jain divides his work into six main sections dealing with (1) Nature and History of Jain Canon ; (2) Administrative organisation ; (3) Economic aspects ; (4) Social conditions ; (5) Geographical material ; and (6) Some important kings and dynasties, i.e., historical material. Of these, sections 3 and 4 are more interesting and informative than others, in view of what is said above. In section 3, the author has collected ample material from the Jain Agamas which throws a flood of light on the conditions of agriculture and other productive occupations of those days, as also of trade, labour and transport. In a separate chapter of this section, the author has collected evidence from the Jain Agamas about food, dress and luxuries of the Jain society and about food of the Jain Sādhus in particular. But, when in his paragraphs on food, wine and meat-eating, the author makes some observations on the prevalence of these things

in the society, we must not be misled into thinking that this was so among the Jain laymen in particular. It was common to the masses, though attempts were constantly made by the leaders of Jainism to inculcate abstention from wine and flesh-eating, as a part of religious dogma, among their followers. References to meat-eating among the Jain Sādhus must of course be understood as under very special circumstances and the general statement which the author makes in the last paragraph under the subsection on meat-eating on pp. 127-128 is, we think, not supported by facts as disclosed by the Jain Agamas.

In section 4, the chapter on the position of women is particularly interesting, more especially, the paragraphs on the female ascetics. Under the paragraph "course of study" on p. 170, it should be noted how the works and subjects of study mentioned the Jain Agamas constitute a course of study which was in no way peculiar to the Jains, but was common to all students of the Aryan community of ancient India, of which the Jains formed only a part. How could otherwise the Vedas and the Vedāṅgas etc., be included in this course? On the other hand, chs. 5 and 7 of this section namely the fourth, contain valuable information about religious conditions, manners and customs specially obtaining among the Jain Sādhus. Geographical lexicon given in ch. 4 of the next section (on pp. 263 to 366) is a very valuable contribution to scholarship. One should have liked to see a similar list of historical or semi-historical persons in the next section, where in the second chapter, an index of important kings and dynasties alone is given.

We heartily welcome this scholarly presentation of facts about life in ancient India as gathered from the Jain canonical works and congratulate the author on the same.

—H. D. VELANKAR

Jivānandanam of Ānandarāya Mukhin, edited by Vaidyaratna Pandit M. D. Aiyangar, with his own Commentary called *Nandini*. Adyar Library, Adyar, Madras. 1947. Price Rs. 20-0-0.

JIVĀNADANAM is a Sanskrit drama embodying the teaching of the Ayurveda and also of the Advaita Vedānta philosophy. The author Ānandarāya Mukhin was the Dharmādhikarin during the reigns of the Maratha kings Sahaji and Sarfoji of Tanjore in the 17th century A.D. An edition of this drama was first published in Telugu script at Mysore, 1881 A.D. Another edition in the Devanagari script was published in the Kāvya-mālā series in 1891 at Bombay. This latter edition is full of "mistakes and irregularities." So the present editor has brought out this new edition and published an exhaustive commentary of his own on it. This new edition is based on the two printed editions mentioned above. Evidently, the Telugu edition and the author's knowledge of the Ayurveda, Sanskrit Dramaturgy and language have helped him to improve upon the Bombay edition. No additional manuscript material has been used for this edition, which however, is bound to be very useful through its exhaustive commentary.

—H. D. VELANKAR

Prākṛtaprakāśa of Vararuci, with the Commentary of Rāma Pāṇivāda, edited by Dr. C. Kunhan Raja and K. Ramcandra Sarma. Adyar Library, 1940. Price Rs. 4-4-0.

VARARUCI'S PRAKRTAPRAKASA was first published by Cowell with Bhāmaha's commentary and an English translation in 1854. This was revised by Dr. P. L. Vaidya and published in Poona, 1931. In the present edition, the commentary of Rāma Pāṇivāda is published for the first time. Rāma was a Southerner and an author of some Prākṛta poems. The edition is based on three manuscripts, two of which are written in Malayālam characters and the third is a recent Devanāgarī transcript of a similar ms. in the Cochin State.

The text of the Sūtras as known to our commentator is substantially the same as that of Bhāmaha; but in Bhāmaha's version, the 5th chapter of our text is sub-divided into two chapters, first ending with the 44th Sūtra. Besides, the last two chapters, i.e., the 10th and the 11th in Bhāmaha's text are unknown to our commentator. Some editions of the Prākṛtaprakāśa give also one more chapter, but this seems to have been unknown to Bhāmaha who does not comment on it.

The variants from the manuscripts are given at the end of the book (pp. 151-198). Indexes of the Sūtras, the Prākṛta words occurring in the commentary and examples quoted by the commentator are added on pp. 95-141. The three chapters which are sometimes ascribed to Vararuci as said above, are also given here, the first two with the commentary ascribed to Bhāmaha, on pp. 143-150. The edition will prove extremely useful to a student of Prākṛta grammar and the evolution of the Prākṛtas in South India in particular.

—H. D. VELANKAR

Song of the Spirit (Selected Verses of S'ami—A Mystic of Sind), translated by Shanti L. Snahani, with a Foreword by Sadhu T. L. Vaswani. Allaharakhia's Bungalow, Behind Mayo College, Ajmer. Price Rs. 3-0-0.

ONE does not know much about Sindhi literature, especially the original Sindhi literature in the past. As a matter of fact, there have been very few original Sindhi publications, and a large amount of translations in Sindhi cropped up only during the last fifty years or so. Some efforts in original writing, however, have been made by the youthful writers just since last ten years or so, but that literature will have yet to find its place in the future. All this time the Sindhi literature has been proud of two classical Poets at any rate—Shah Abdul Latif and S'ami; the former has given us the songs of Sufism, and the latter has given us the philosophy of Vedanta. The songs of both these great Poets have become our national heritage.

Sind has undergone the influences of its different Rulers from time to time, and particularly the Sind Hindus have hardly maintained their originality in all spheres of life, including customs, clothes, etc. Till recently they were under the Western influence, which at present they have not yet discarded. Maybe, they have retained individuality of self-respect and self-dependence. But speaking of Sindhi literature, as it has Arabic script since the last century, the Sind Hindus have not much remained in touch with the Hindu literature of the rest of India. S'ami, however, has filled this gap and given them the nutshell of the Hindus' Wisdom of Vedanta. As Sadhu T. L. Vaswani has said in his Foreword to the book under review: "The heart of S'ami's *slokas* is set upon living and loving union with One who transcends Many that change and pass. The 'Many' are the veils of *Maya*: they shut off the Light; they must be pierced to uphold the adorable Faces of the Beloved."

S'ami is indeed the unique figure in Sindhi literature. He has dealt primarily with the field of inner exploration and illumination, making our hearts whole, transforming us into his spiritual supermen, by realising the God within, putting us in tune with Infinite. By initiation and inner striving, S'ami found the way to the "inmost centre in us all, where Truth in its fullness doth abide," and brought out jewels of that Truth that met his quickened insight.

To know something of S'ami, he was the son of a rich merchant. However, instead of the material treasures he went after the spiritual ones. He found his *Sat-Guru*, his spiritual Master, and has composed his *slokas* after his name, reverentially calling him S'ami or Master. Chainrai, which is the original name of the Poet, was charmed by the S'ami's personality, at whose feet he tried to study and to practice meditations. Later he poured out his realisations in the forms of *slokas*, which it is said, were written by him on mangoleaves and slips of papers and accumulated in a big earthen jar. These were collected by his son, who showed them the light of the world. The language of the *slokas* is Sindhi and the script Gurmukhi. They numbered about 4400, of which 2100 were published by Dewan Kauromal in Sindhi in the Arabic script.

Again this raises the point of the script of Sindhi, which the reviewer has been feeling should be Devanagari. When one reads the literature in Hindi, Marathi, Gujarati and Bengali, he finds that Sindhi also is a real sister of these languages and one of the daughters of the Sanskrit language, from which all these languages, including Sindhi of course, have been derived. Nobody has disputed this fact and also the fact that writing and reading in Devanagari script is more scientific and easy than the present Sindhi script, connected with Arabic and forced on the Sindhis by a Britisher not even a hundred years back, in about 1852. Prior to that the Hindus of Sind used Devanagari script for their language.

Leaving the above controversy at that and coming again to S'ami's *slokas*, they contain hints on right living, understanding the Great Within, developing Self-realisation and God-realisation. He has endeavoured through them to lead his readers to seek and find the Kingdom of Heaven within, in the simplest way possible, declaring his universal message, and bearing witness to the Light within Light that lighteth every man, and the Voice of Silence, the music and melody of the Song of Life which everyone may hear who has developed the inner ear. They are quite simple, rhythmic, and are in the form of quatrains, some of which have been selected and rendered into English by Mr. Shanti L. Shahani.

The translation is not literal, the rhyming defective in many places, and as regards the metre less said the better. One wonders too if these verses, or at least most of them, are able to convey the real spirit of the *slokas*, for how can they? The reviewer himself attempted writing English poetry in his young days, and was advised by a none greater English Poet than Shrimati Sarojini Naidu herself not to write English poetry, as rightly one hardly can express himself as beautifully and properly in a strangers' language. The other argument was that after all, something written in a foreign language may not remain with us permanently. We have a glaring example of this in Sind. When Persian was the court language of the Sind Government, the Sind Amils, highly placed Government officials, wrote literature, mostly poetry, in Persian. And there is scarcely a piece from that vast literature which is known to Sind today.

However, at present these English rendering of the S'ami's *slokas* would be helpful in bringing their light to the English reading public here and abroad, which may by itself be reckoned as a great service, for which they should be grateful to the Translator. May we learn from it the mystic Poet's message, which in short is a response of a human being of realisation to the edict and urge of the ages and the sages, "Know Thyself!"

—SHEWAK

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Kashi Nagri Pracharini Saba, Benares, for the year 2003.

Descriptive Catalogue of the Pali Manuscripts in the Adyar Library, by E. W. Adikaram, Madras, 1947.

History of Philosophy, by Clement C. J. Webb. Home University Library of Modern Knowledge ; Oxford University Press.

Hungarian Libraries Board, Budapest—University Curricula (5 publications).

Karl-Marx—His Life and Environment, by Isaiah Berlin. Home University Library of Modern Knowledge ; Oxford University Press. Price 5s.

La Grammaire de Passini, traduite du Sanskrit Anec des extraits des commentaires indigenes, par Louis Renou, Fascicule I, Paris, 1948.

Last Chronicle of Barseet, the—, by Anthony Trollope, 75, Oxford University Press. Price 7s.

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SOME PROPERTIES OF A FUNCTION OF RAMANUJAN

By S. M. SHAH AND U. C. SHARMA

1. LET w and t be two variables such that $0 \leq w \leq 1$, $t \geq 1$ and $w e^{-w} = t e^{-t}$. Let $\phi(t) = w/t$ ($t \geq 1$). In this note we consider $\frac{d^r \phi}{dt^r}$ and prove that

$$(-1)^r \frac{d^r \phi}{dt^r} \geq 0 \text{ for } t \geq 1, r=1, 2, 3, 4, \dots \dots \dots (I).$$

2. Let

$$\phi(x) = \sum_{n=1}^{\infty} \frac{n^{n-2}}{(n-1)!} x^{n-1} e^{-n.x}$$

denote Ramanujan function [1, p. 332 Q. 738]. Auluck [2] and Chowla and Auluck [3] proved that

$$(i) \quad \phi(x) = 1, \quad 0 < x \leq 1;$$

$$(ii) \quad \phi(t) = w/t \quad (t \geq 1), \text{ where } w \text{ and } t \text{ are defined above;}$$

$$(iii) \quad (-1)^r \frac{d^r \phi}{dt^r} \geq 0 \quad (t \geq 1), \quad r=1, 2, 3.$$

For the sake of completeness we prove (I) in cases $r=1, 2, 3$ also. Our proof of part (i) of Lemma I below is different from theirs and proofs of the parts (ii) and (iii) of Lemma 1 depend on (i).

3. Lemma I. (i) $w+t \geq 2$, equality holds if $t=w=1$;

$$(ii) \quad wt \leq 1;$$

$$(iii) \quad w+t+2wt \geq 4.$$

Proof:

(i) Let $t = 1 + x$, $w = 1 - y$. We have then $x \geq 0$, $0 \leq y \leq 1$ and $e^{x+y} = \frac{1+x}{1-y}$, and we have to prove that $x \geq y$. Since $y \leq 1$ always we need consider only the case when $x < 1$. Hence $y < 1$ for when $y=1$, $w=0$, $t=\infty$, $x=\infty$,

Suppose, if possible, $y > x$. Then

$$\begin{aligned} 0 &= x + y - \log(1+x) + \log(1-y) \\ &= \int_0^x dt - \int_0^x \frac{dt}{1+t} + \int_0^y dt - \int_0^y \frac{dt}{1-t} \\ &= - \left[2 \int_0^x \frac{t^2 dt}{1-t^2} + \int_x^y \frac{t dt}{1-t} \right], \end{aligned}$$

which is impossible if $y > x$. Hence $y \leq x$; equality if $x = y = 0$.

(ii) Let $Y(t) = wt$.

$$\frac{dY}{dt} = \frac{w}{1-w} (2-w-t) \leq 0.$$

Hence $Y(t)$ is decreasing as t increases, and so

$$Y(t) \leq Y(1) = 1 \quad \text{for } t \geq 1.$$

(iii) Let $Y(t) = w + t + 2wt$.

$$\frac{dY}{dt} = \frac{(w+t)(1-2wt) + 2wt}{t(1-w)} \geq \frac{2(1-2wt) + 2wt}{t(1-w)} \geq 0.$$

Hence $Y(t)$ is increasing with t and so $Y(t) \geq Y(1) = 4$.

Lemma 2. (i) $\phi^{(1)}(1+0) = -2$;

(ii) $\phi^{(2)}(1+0) = -16/3$;

(iii) $\phi^{(3)}(1+0) = -56/3$;

(iv) $\phi^{(4)}(1+0) = \frac{3712}{45}$.

The first two results have been proved by Auluck [2].

$$(iii) \quad \frac{d^3 w}{dt^3} = - \frac{w(t-w) \{ (t-1)(w+t+2wt-4) + 2(1-w)^2(w+t-2) \}}{t^3(1-w)^5}$$

Hence

$$\left(\frac{d^3 w}{dt^3} \right)_{t=1+0} = \lim_{x \rightarrow 0} \left\{ - \frac{(1-y)(x+y) \{ x(3x-3y-2xy) + 2y^2(x-y) \}}{(1+x)^3 y^5} \right\}$$

Where [3, p. 171-2] $x=y + \frac{2y^2}{3} + \frac{4}{9}y^3 + \frac{44}{135}y^4 + \dots$

Hence

$$\left(\frac{d^3 w}{dt^3} \right)_{t=1+0}$$

Since $\frac{d^3 w}{dt^3} = t \phi^{(3)}(t) + 3 \phi^{(2)}(t),$

We have $-\frac{8}{3} = \phi^{(3)}(1+0) + 3 \cdot \frac{16}{3},$

And (iii) follows.

$$\begin{aligned} \text{(iv)} \quad \frac{d^4 w}{dt^4} &= \frac{w(t-w)}{t^4(1-w)^7} \left\{ \begin{aligned} &4(t-1)(1-w)^2(w+t+2wt-4) \\ &+ 6(1-w)^4(w+t-2) + 4w(t-1)^2(w+t+2wt-4) \\ &- 2(1-wt)(t-1)(1-w)(w+t-2) \\ &+ (t-w)(w+t-2)(w+t+2wt-4) \end{aligned} \right\} \\ &= \frac{(1-y)(x+y)}{(1+x)^4 y^7} \left\{ \begin{aligned} &4xy^2(3x-3y-2xy) + 6y^4(x-y) \\ &+ 4(1-y)x^2(3x-3y-2xy) \\ &- 2(xy-x+y)xy(x-y) \\ &+ (x+y)(x-y)(3x-3y-2xy). \end{aligned} \right\} \end{aligned}$$

Hence

$$\left(\frac{d^4 w}{dt^4} \right)_{t=1+0} = \frac{32 \times 11}{45}.$$

But

$$\frac{d^4 w}{dt^4} = t \phi^{(4)}(t) + 4 \phi^{(3)}(t).$$

Hence $\phi^{(4)}(1+0) = \frac{32 \times 11}{45} + 4 \cdot \frac{56}{3} = \frac{3712}{45}.$

4. Proof of (I). We have

$$\frac{dw}{dt} = -\frac{w(t-1)}{t(1-w)} \leq 0$$

$$\frac{d^2 w}{dt^2} = \frac{w(t-w)(w+t-2)}{t^2(1-w)^3} \geq 0$$

$$\frac{d^3 w}{dt^3} = -\frac{w(t-w) \{ (t-1)(w+t+2wt-4) + 2(1-w)^2(w+t-2) \}}{t^3(1-w)^5} \leq 0$$

for $t \geq 1$.

$$\begin{aligned} \frac{d^4 w}{dt^4} &= \frac{w(t-w)}{t^4(1-w)^7} \left\{ \begin{aligned} &4(t-1)(1-w)^2(w+t+2wt-4) \\ &+ 6(1-w)^4(w+t-2) + 4w(t-1)^2(w+t+2wt-4) \\ &- 2(1-wt)(t-1)(1-w)(w+t-2) \\ &+ (t-w)(w+t-2)(w+t+2wt-4) \end{aligned} \right\} \\ &= \frac{w(t-w)}{t^4(1-w)^7} \{ \Sigma_1 + \Sigma_2 + \Sigma_3 + \Sigma_4 + \Sigma_5 \} \end{aligned}$$

Now $\Sigma_1 \geq 0, \Sigma_3 \geq 0$ for $t \geq 1$.

$$\Sigma_2 + \Sigma_4 + \Sigma_5 = (w+t-2) \left\{ \begin{aligned} &(t-4)(t-2) + 2w(2-w)(t^2 - \frac{1}{2}t) \\ &+ 24w^3(1-w) + 6w^4 \end{aligned} \right\}$$

$$\geq 0 \quad \text{if } t \geq 4.$$

If $t < 4$ let $t=1+x$, $w=1-y$ then $0 \leq x < 3$, $0 \leq y \leq \text{Min}(1, x)$ and from Lemma 1 (iii) we have $3x-3y-2xy \geq 0$.

Hence

$$\begin{aligned} \Sigma_2 + \Sigma_4 + \Sigma_5 &= (x-y) \{ (3x^3 - 2x^2y^2 - 4xy^3 - 3y^3 + 6y^4) \\ &\geq (x-y) \{ 3xy + 2x^2y - 2x^2y^2 - 4xy^3 - 3y^3 + 6y^4 \} \\ &= (x-y) \{ 2x^2y(1-y) + 3xy - 4xy^3 + 6y^4 - 3y^3 \} \\ &\geq \frac{(x-y)}{(3-2y)^2} \left\{ 18y^3(1-y) + (3y-4y^2)3y(3-2y) \right. \\ &\quad \left. + (6y^4-3y^2)(3-2y)^2 \right\} \\ &= \frac{(x-y)y^3}{(3-2y)^2} \{ 24y^2(2-y)(1-y) \} \geq 0. \end{aligned}$$

Hence $\frac{d^4w}{dt^4} \geq 0$ if $t \geq 1$.

Now

$$\phi^{(1)}(t) = \frac{1}{t} \frac{dw}{dt} - \frac{w}{t^2} \leq 0$$

$$\phi^{(2)}(t) = \frac{1}{t} \frac{d^2w}{dt^2} - \frac{2}{t^2} \frac{dw}{dt} + \frac{2w}{t^3} \geq 0$$

$$\phi^{(3)}(t) = \frac{1}{t} \frac{d^3w}{dt^3} - \frac{3}{t^2} \frac{d^2w}{dt^2} + \frac{6}{t^3} \frac{dw}{dt} - \frac{6w}{t^4} \leq 0$$

$$\phi^{(4)}(t) = \frac{1}{t} \frac{d^4w}{dt^4} - \frac{4}{t^2} \frac{d^3w}{dt^3} + \frac{12}{t^3} \frac{d^2w}{dt^2} - \frac{24}{t^4} \frac{dw}{dt} + \frac{24w}{t^5} \geq 0$$

which completes the proof.

REFERENCES

1. Srinivasa Ramanujan. Collected Papers (1927).
2. F. C. Auluck. On Some Theorems of Ramanujan : Proc. Indian Aca. of Sciences 11, No. 4, Sec. A (1940), pp. 376-378.
3. S. C. Chowla and F. C. Auluck. Some Properties of a Function Considered by Ramanujan ; Indian Math. Soc. J. 4 (1940), pp. 169-173.

ON THE MECHANISM OF THE FRIES MIGRATION

By G. C. AMIN AND N. M. SHAH

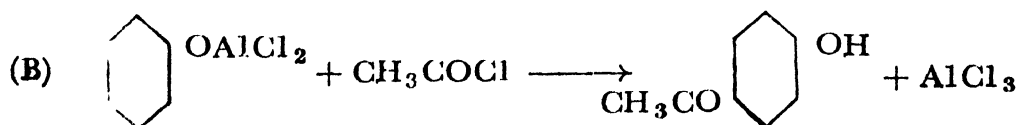
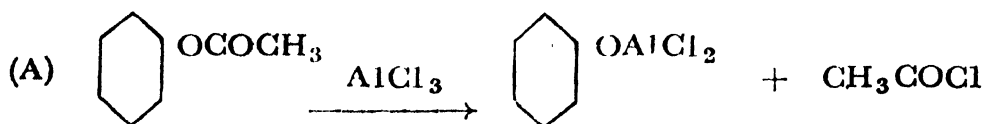
THE migration of an acyl group in phenolic esters under the influence of metallic halides, particularly aluminium chloride, is one of the useful methods of preparing ortho- and para-hydroxy ketones. Since the work of Fries (Ber. 1908, *41*, 4271 ; 1910, *43*, 314), who first contrived this reaction, much work has been done on it both with a view to prepare the specific ketonic compounds and also to investigate the conditions affecting the course of this reaction (Auwers and co-workers, Ann., 1928, *460*, 240 ; Ber., 1928, *61*, 1495 ; Rosenmund and co-workers, Ann., 1928, *460*, 56 ; Ber., 1928, *61*, 2602 ; Cox, J. A. C. S., 1930, *52*, 352 ; Ralston and co-workers, J. Org. Chem., 1940, *5*, 645 ; 1941, *6*, 751 ; Skraup and Poller, Ber., 1924, *57*, 2033).

The perusal of literature shows that different investigators as a result of their studies have put forward different views to explain the mechanism of the Fries migration. It will be not expeditious to detail all of them here. However, some of the views which merit a detailed mention are outlined here.

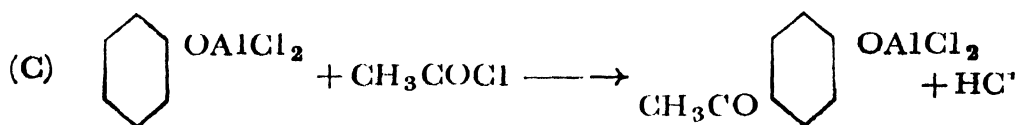
According to the view put forth by Fries (Fries *et al*, loc. cit.) and Witt and Braun (Ber., 1914, *47*, 3216) and later developed by Auwers and co-workers (*loc. cit.*), the Fries reaction involves a true intramolecular rearrangement. They differentiated the Fries reaction from the Friedel-Crafts, as in the former the acyl group comes from *within* the molecule, while in the latter, it comes from *without* the molecule. They stressed that the meta compound may be formed in the Friedel-Crafts reaction, but the Fries migration exclusively leads to the ortho- or para-hydroxy ketones and hence they consider this displacement as intramolecular. However, the formation of the meta compound is not unknown in the Fries reaction, *e.g.*, guaicol acetate migrates under the conditions of Fries reaction giving along with other products small quantity of the meta compound. (Reichstein, Helv. Chim. Acta, 1927, *10*, 392). But it is difficult to rely on the comparison between these two reactions when they have been carried out with different starting materials. Auwers carried out the Friedel-Crafts acetylation with methyl ethers of phenols and it is plausible that the methoxy group may direct the acetyl group differently. In spite of these objections, there is no definite evidence against the view.

The second view is due to Skraup and Poller (*loc. cit.*) and supported by Cox (*loc. cit.*). According to these authors, the reaction involves two steps :

- (A) Formation of acid chloride and phenoxy aluminium chloride from the phenol ester by the action of aluminium chloride and
- (B) The formation of the hydroxy ketone by the action of acid chloride on the phenoxy aluminium chloride.

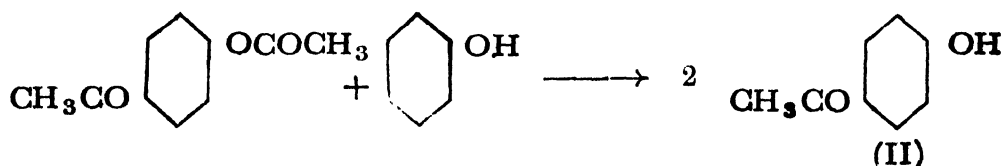
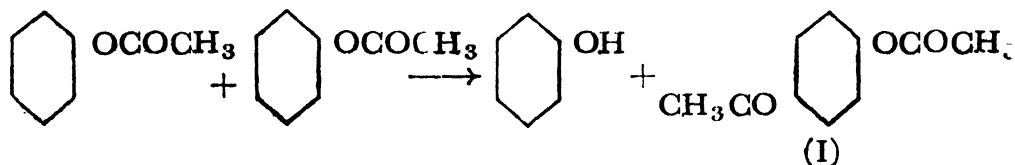


In this case the reaction is quite similar to the Friedel-Crafts acylation. It is suggested to write (B) in the form (C) shown below as HCl is found to evolve during the course of the reaction.



It can be stated against this mechanism that there are instances known where Friedel-Crafts reactions fail absolutely, while the Fries reaction give good yields (Cox, *loc. cit.*; Rosenmund *et al.*, *loc. cit.*). Again, it is not confirmed that this splitting (reaction A) is a necessary step in this reaction. However, this mechanism has been supported by several investigators (Mottern, J.A.C.S., 1934, 56, 2107; Cryser, Trans Roy. Soc. Canada, 1925, III, 3, 129; Fieser and Bradsher, J. A. C. S. 1936, 58, 1738, 2337).

As a result of extensive study of this reaction, Rosenmund and Schnurr (*loc. cit.*) have put forward a different view on the mechanism of the Fries migration. They explain that in this reaction, one molecule of the ester acylates a second molecule, as in the Friedel Crafts reaction where acetic anhydride is an acylating agent. Hence the reaction is inter-molecular.



Recent work has supplied evidence in support of this view. Ralston and co-workers (*loc. cit.*) were able to isolate the intermediate product of the type $p\text{-RCO-C}_6\text{H}_4\text{-OCOR}$ (I) formed as in the first step of the mechanism. Ralston and co-workers have also shown that this compound can react with phenol in the presence of aluminium chloride to give hydroxy ketone (II). The work of Tarbell and Fanta (J. A. C. S., 1943, 65, 2169) also support this mechanism. This view neatly explains the results of the experiments and indicates the possible direction of the reaction, but does not definitely prove the course of the reaction.

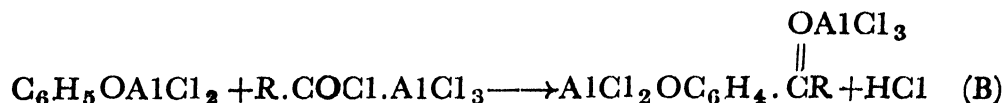
At this stage, it will not be out of place to point out, that all the observations put forth in support of the view of Skraup and Poller and of Cox can also be lucidly explained by this interpretation ; while the results of Rosenmund and Schnurr's work can be equally well explained by the mechanism of Cox.

Ralston and co-workers (*loc. cit.*) have put a slightly different explanation depending upon the amount of aluminium chloride used. This mechanism embraces more or less all the above views. According to them, when more than one mole of aluminium chloride is required, there is a possibility for both phenyl and acid chloride, which are formed by the action of aluminium chloride on the phenolic ester, to form aluminium chloride complexes. They have applied their view to explain the migration of simple phenyl acetate in the following manner :—



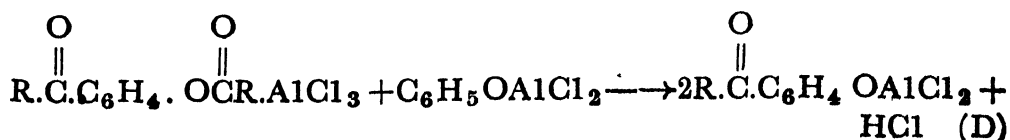
The reaction then follows one of the two courses indicated below :

(I) The phenoxy-aluminium chloride may be acylated, thus



On decomposing the last ketonic complex with ice and hydrochloric acid, the migrated product is obtained.

(II) The original ester may be acylated first and this product reacts with phenoxy-aluminium chloride, thus

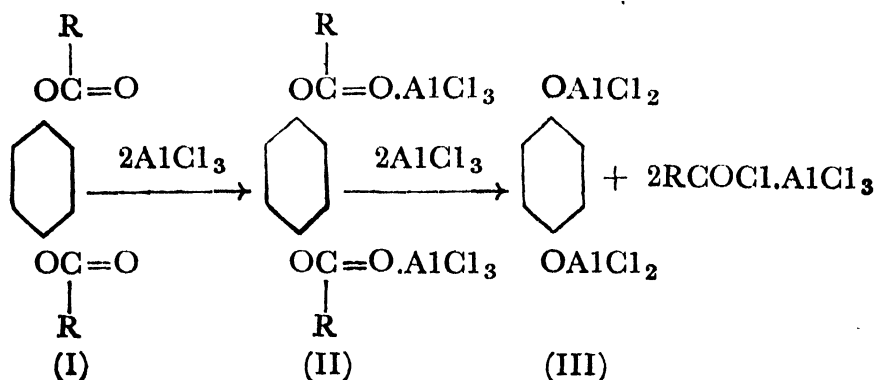


Finally they have argued that the splitting of the ester molecule (A) does not take place instantaneously, but at intermediate stages, ester-aluminium chloride, phenoxy aluminium chloride, acid chloride, and aluminium chloride salts of the migrated products are present. Hence they concluded that after the rearrangement has progressed to an appreciable extent, there are separate reactions, some of which may predominate in the earlier stages of the reaction, while others may be dominant in the later stages.

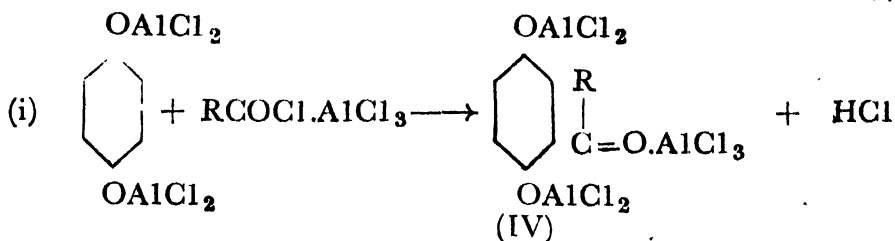
It may be pointed out here that the earlier investigators had based their various interpretations of the Fries migration on the results obtained by the study of the hydroxy-benzene derivatives: compounds containing nuclei other than benzene or naphthalene had been little investigated. Recently, Thakore and Shah (J. I. C. S., 1916, 23, 199, 213) extended the Fries reaction to the heterocyclic compounds like the esters of hydroxy-coumarins. They found that the three moles of aluminium chloride are necessary to effect the migration. When the amount of aluminium chloride used is less than three moles, either the cleavage product is formed or the original ester is recovered unchanged. They have accounted for the three moles to the tendency of the coumarin to form complexes with 'O' and 'CO' of the coumarin nucleus. Thus, two moles will be utilised in the complex formation and the third one brings about the migration. That the amount of aluminium chloride required to effect this migration is three moles is seen in several other cases, *e.g.*, acyl esters of hydroxy-benzoic acids, quinol esters (unpublished work) hydroxy-quinoline esters (Thakore, private communication).

In the case of the Fries migration of the quinol esters, it is also found that three moles of aluminium chloride are necessary. The use of less than three moles yields unchanged ester. It can be accounted by the following explanation according to the view of Ralston and co-workers (*loc. cit.*).

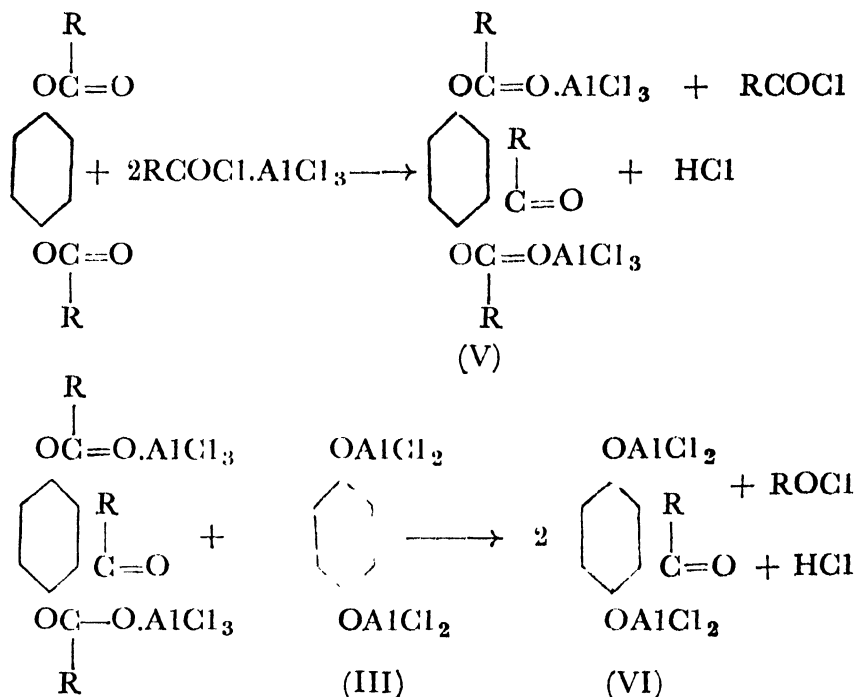
In the case of the quinol esters, there are two oxygen atoms, which can form complexes with aluminium chloride and hence two moles will be utilized in complex formation. However, the nature of the complex and the mode of combination of aluminium chloride with oxygen atoms is not known. Such ester complexes have been isolated as intermediate product in many reactions (Gustavson, Bull. Soc. chim., 1880, (2), 34, 322; Perrier, Compt. rend., 1893, 116, 1141; Bull., Soc., chim., 1893 (3), 9, 1049; Walker and Spencer, J. C. S., 1904, 85, 1108; Schonberg and Mustafa, J. C. S., 1943, 79). If now the view is applied as shown to quinol esters, the reaction involved therein can be expressed by the following equations:—



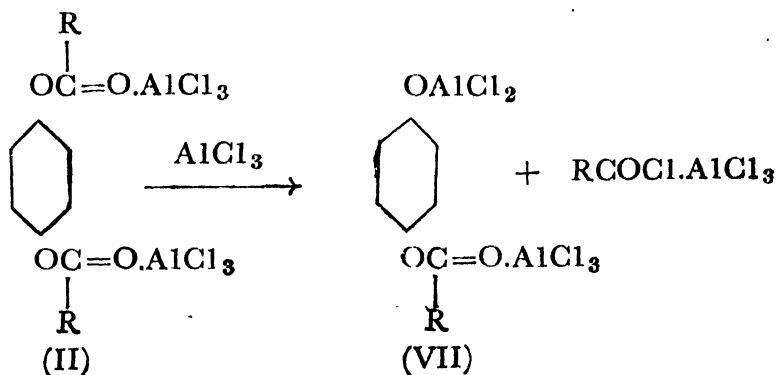
Now the reaction may proceed by one of the two following courses:—



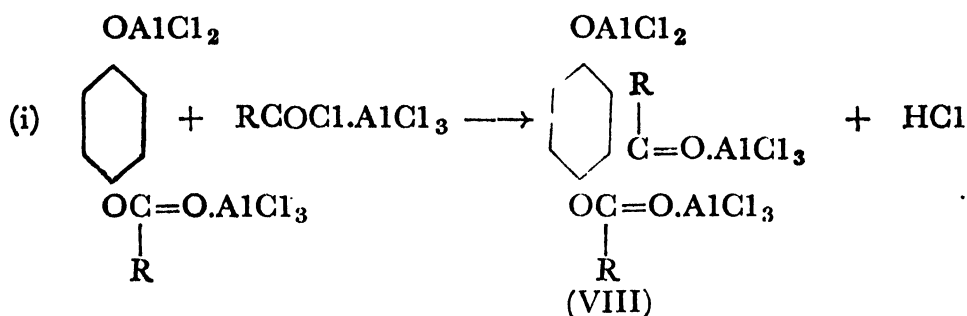
or (ii) another molecule of quinol ester is acylated first and this product reacts with quinoxaluminium chloride, thus



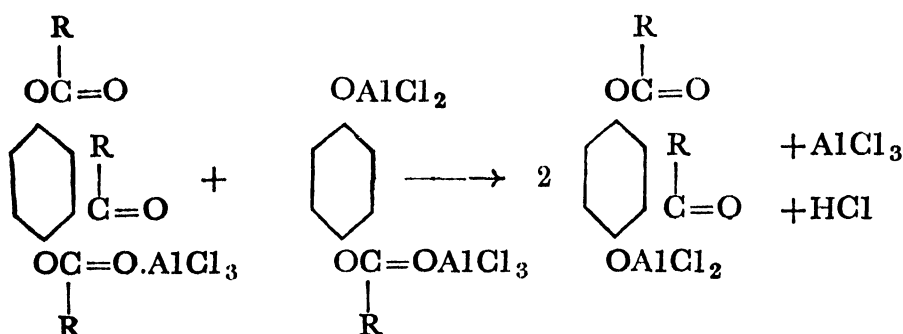
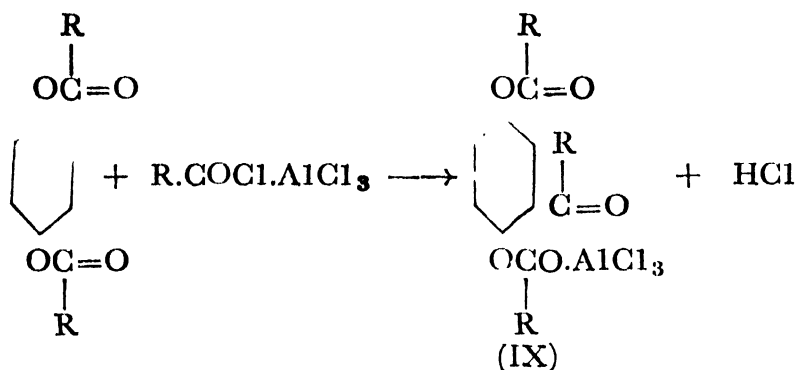
As will be seen from the above equations, apparently four molecular proportions of aluminium chloride are involved in the migration of quinol esters while actually the migration is possible with three moles. So it is probable that ester-aluminium complex (II) may not be completely decomposed into quinoxaluminium dichloride and two moles. of acid chloride (III) but the reaction may have taken up the following modified course:—



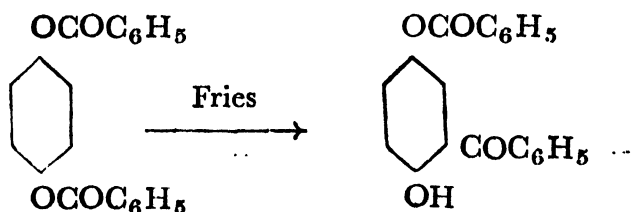
And other steps may be conveniently written as follows :—



and for (ii)



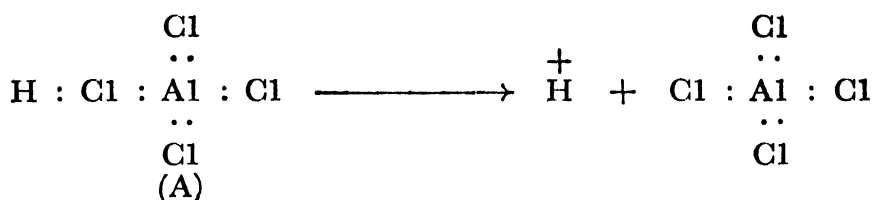
On decomposition of the product by ice and hydrochloric acid, mono-aryloxy ketone will be obtained according to the equations. Such a mono-aryloxy ketone has been actually isolated as a main product among other products when quinol dibenzoate is subjected to the Fries migration using three moles of aluminium chloride at requisite temperature.



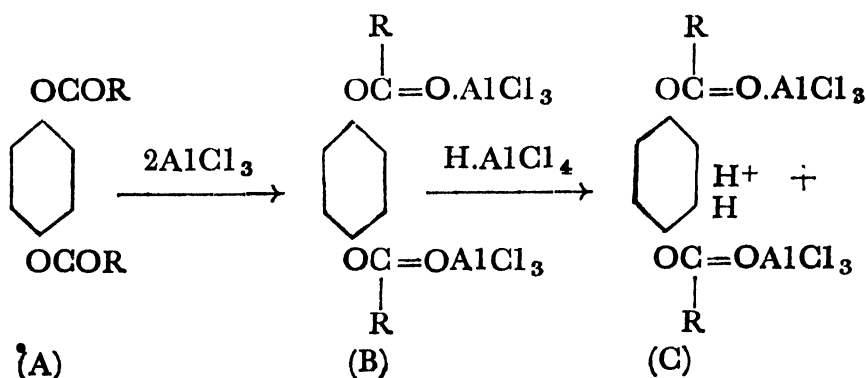
It will be seen from the above discussion that at least three molecules of aluminium chloride are required to effect the migrations in case of the quinol esters. The earlier attempts for the migration of quinol diacetate were fruitless. This may be due to the insufficient quantity of the migrating agent used by earlier workers [Heller, Ber., 1912, 45, 2389; Mauthner, J. prakt. chem., (2), 149, 324]. Further increase in the amount of aluminium chloride does not lead to an increase in the yield of the migration product nor does it decrease the formation of other products.

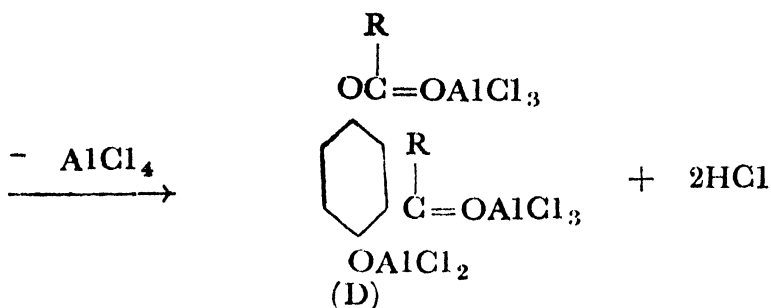
There is also another possibility : the migration of both the acyl groups, but such a diketone was not isolated in any of the experiments.

An explanation applicable to all the reactions involving the use of aluminium chloride has been put forth by C. A. Thomas (Anhydrous Aluminium Chloride in Organic Chemistry, p. 72-76). According to this view, it is assumed that the anhydrous aluminium chloride used in the reaction always contains some amount of hydrogen chloride because absolutely anhydrous aluminium chloride has been not prepared by any one working in that field. Secondly, the mode of the combination of this hydrogen chloride is not known but as aluminium chloride forms additive compounds with many chlorides, it may form a compound of some such constitution. Hence analogous to NaAlCl_4 , the compound with HCl may be put as HAlCl_4 which has not been yet isolated. Such a compound will have unusual catalytic properties. The electronic structure of it can be represented by (A) and it may be assumed to ionize as shown below :—



The formation of the very reactive proton as postulated above, is the cause of the catalytic effect noticed in the reactions in general. If the above protonic theory is applied to Fries migration of quinol esters, the mechanism of the migration can be very neatly explained.





First ester-aluminium chloride complex is formed by two moles of aluminium chloride (B) and third molecule of aluminium chloride takes part in the activation. As the ester molecule is completely symmetrical, activation of any one of the four atoms of hydrogen attached to the corresponding four atoms of carbon in the ring, will form only one product. The activated ester complex will be in the state shown by (C). Such a molecule is always unstable and substituents attached to the nucleus try to arrange in such a way, that the molecule as a whole is in a state of the least strain or in other words, the molecule rests in a state of lowest possible energy level. So one of the two ester groups (OCOR) will try to readjust itself and consequently it will attach to the position next to it, which is activated. In this way one migration product will be obtained (D), which on being decomposed by ice and hydrochloric acid in the usual manner, monoacyl ester of the ketone will be obtained. However in the case of the migration of quinol diacetate, quinacetophenone is produced which can be attributed to the easy hydrolysis of the ester-aluminium chloride complex but in the case of quinol dibenzoate, monobenzoyloxy quinbenzophenone is formed indicating that such an ester-aluminium complex *does* exist in the final product.

So far as it goes, the above explanation based on the proton theory furnishes an explanation of the cause of the Fries migration and is in uniformity with other reactions in which aluminium chloride is used.

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ACRIDINE DERIVATIVES AS ANTIMALARIALS

Part I. 5-amino derivatives of 3-7-dimethoxy acridine

**Part II. 5-amino derivatives of 3-7-dimethoxy-6-chloro and
3-7-dimethoxy-8-chloro acridine**

By S. R. PATEL AND K. S. NARGUND

**Part III. 5-amino derivatives of 7-methoxy-2-8-dichloro and
7-methoxy- 2-6-dichloro acridine**

Part IV. 5-amino derivatives of 7-methoxy-8-chloro acridine

Part V. derivatives of 2-8-dichloro acridine

By K. C. KSHATRIYA AND K. S. NARGUND

IN this series of papers a description is given of the synthesis of 5-amino derivatives of substituted acridines the numbering in the acridine nucleus being as shown below.

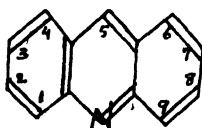


Fig. No. 1

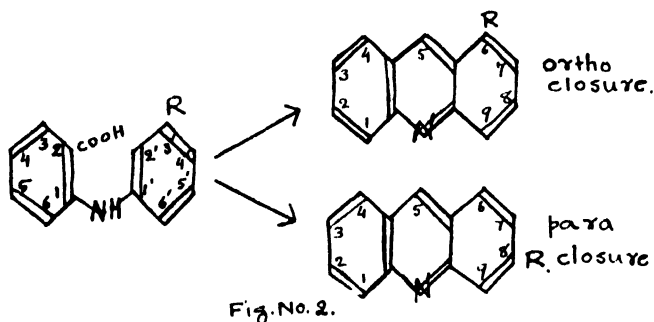
The compounds described are similar to atabrine and should prove of value as antimalarials. Unfortunately due to want of chemicals, consequent upon the restrictions on the importation of chemicals it was not possible to prepare dialkylamino-alkylamino derivatives of these acridines so that the compounds could be tested for anti-malarial property. It is intended, however, to report these derivatives as soon as the chemicals become available.

The presence of a methoxy group in a compound has been shown by Shaw (American Jour. Hyg. 8, 583 1925) to increase the permeability of the compound and thus to increase its effectiveness as a drug. The presence of methoxy group para to ring nitrogen is to be found in quinine, plasmoquin and atabrine thus indicating its importance in that position. Chlorine in any position in the acridine nucleus has been shown to endow the compound with anti-malarial property. (Magidson and Grigorovsky B. 69 396. 1936). Atabrine has chlorine meta to the ring nitrogen of the acridine nucleus. Hence in the compounds described below we have kept these orientations in tact *viz.*, methoxy para to ring nitrogen and chlorine meta to the ring nitrogen of the acridine nucleus.

Synthesis of the above type of compounds proceeds through the following three steps. (i) the preparation of a properly substituted diphenyl amine-2-carboxylic acid. (ii) ring closure of this acid by phosphorus oxychloride to obtain substituted 5-chloro-acridine and (iii) the condensation of the chloro-acridine with an appropriate amine.

The preparation of the diphenyl amine-2-carboxylic acids used in the present work has already been described by Kshatriya, Patel and Nargund. (Jour. Bom. Univ. Vol. 15 Part 3, page 42.) These were then heated with phosphorus oxy-chloride at 120° to obtain the corresponding 5-chloro-acridines which were then condensed with various amines by Magidson's procedure to obtain the 5-amino derivatives.

While 2' and 4' substituted diphenyl amine-2-carboxylic acid can undergo cyclisation with the formation in each case of only one chloro-acridine the 3' substituted diphenyl amine-2-carboxylic acid may give rise to 6 or 8 substituted 5-chloro-acridine according to whether the ring closes on 2' position (ortho closure) or 6' position (para closure) as shown below.



Usually both the above types of compounds are obtained the proportion of the two isomers varies depending upon the nature of 3' substituent. (Albert and Linnell J. C. S. 1936, 88. Lohmstedt and Schrader B. 70, 838 1937 Bradbury and Linnell J. C. S. 1942, 377.)

The action of phosphorus oxychloride on 3'-chloro-4,4'-dimethoxy diphenyl amine-2-carboxylic acid gave two isomeric 5-chloro-acridines viz. 3,7-dimethoxy-5,8-dichloro acridine m.p. 198 and 3,7 dimethoxy-5,6-dichloro acridine m. p. 162. These were separated from the crude reaction mixture by fractional crystallisation from dry toluene. To prove the constitutions of these we have prepared 3,7-dimethoxy-5,8-dichloro acridine by an unambiguous method as follows. m-cresol methyl ether was chlorinated to get 2,4-dichloro-5-methoxy toluene b. p. 250-254. On oxidation this gave 2,4-dichloro-5-methoxy benzoic acid m. p. 190°. This on condensation with p-anisidine under the Ullmann's conditions gave 4,4'-dimethoxy-3-chloro diphenyl amine-2-carboxylic acid m. p. 206 on treating this with phosphorus oxy chloride 3,7-dimethoxy-5,8-dichloro acridine m. p. 198 was obtained. It was identical (mixed m. p.) with one of the chloro acridine obtained from 4,4'-dimethoxy-3'-chloro diphenyl amine -2-carboxylic acid. Hence the constitution of the other product m. p. 162 as 3,7-dimethoxy-5,6-dichloro acridine is automatically settled.

4'-methoxy 3-3' dichloro diphenyl amine-6-carboxylic acid (Kshatriya, Patel and Nargund *loc. cit.*) on treatment with phosphorus oxychloride gave two acridines *viz.* 7-methoxy-2-5-8 trichloro acridine (m.p. 208-209) and 7-methoxy-2-5-6 trichloro acridine (m. p. 180-181). It is impossible to prove the constitutions of these compounds by synthesis. Hence we have assigned the above constitutions by the melting point only. It is always found, in the cases investigated so far, that the product obtained by para ring closure has a higher melting point. (Compare Bradbury and Linnell *loc. cit.*)

Similarly 3'-chloro-4'-methoxy-diphenyl-amine-2-carboxylic acid on treatment with phosphorus oxy-chloride should give two acridines *viz.* 7-methoxy-5-8-dichloro-acridine and 7-methoxy-5-6-dichloro-acridine. We obtained, however, only one isomer in crystalline condition m. p. 198. That its constitution was 7-methoxy-5-8-dichloro acridine was proved by its synthesis as shown below. 2-4-dichloro-5-methoxy benzoic acid described previously in this paper was condensed with aniline under Ullmann's conditions to get 4-methoxy-5-chloro diphenyl amine-2-carboxylic acid m. p. 184-185°. This on treatment with phosphorus oxychloride gave 7-methoxy-5-8-dichloro acridine m. p. 198 identical with the product obtained from 3'-chloro-4'-methoxy diphenyl amine-2-carboxylic acid.

3-3'-dichloro-diphenyl-amine-6-carboxylic acid has already been described (Kshatriya, Patel and Nargund *loc. cit.*). Since then a paper by Spalding, Moersch, Mosher and Whitmore has appeared (J. A. C. S. 1946 1596) in which these authors describe the above acid from the same materials in 6 per cent yield while our yield was 40 per cent. This acid on treatment with phosphorus oxychloride gave much acridone and only a small quantity of 2-5-8-trichloro acridine m. p. 223°. Whitmore et al (*loc. cit.*) who prepared this by another method report the m. p. 223-225. On account of low yield it was not possible to obtain the 5-amino derivatives of this acridine.

EXPERIMENTAL

5-chloro acridines :—substituted diphenyl amine-2-carboxylic acid (one part) was mixed with phosphorus oxychloride (6 parts) and the mixture heated in an oil bath at 120 for two hours. The excess of phosphorus oxychloride was removed under reduced pressure and the sticky residue was treated with ice-cold 10 per cent ammonium hydroxide and allowed to stand for some time. The chloro-acridine separated in powdery form. It was filtered, washed, dried, and then crystallised fractionally from dry toluene.

5-amino acridine derivatives :—5-chloro acridines (one part) was mixed with freshly distilled phenol (8 parts) and the mixture heated on a water bath at 80-90° for 15 minutes. Equivalent quantity of the amine was added and heated for three hours. In some cases it is necessary to keep the temperature at 90-100°. Dry ether was then added and a current of dry hydrogen chloride was passed through it when the hydrochlorides of the 5-amino derivatives separated. It was filtered, washed with alcohol and crystallised from alcohol. The compounds are described in tabular forms.

No.	Name of the Compound	Formula	Preparation and Properties	Analysis	
				Found	Required for
1	Acid chloride of 4,4'-dimethoxy diphenylamine-2-carboxylic acid.	$C_{15}H_{14}O_3NCl$	from the acid and thionyl chloride in petrol solution. sol. in benzene and toluene. Crystallised from petrol. m.p. 92° .	Cl, 12.3	Cl, 12.2
2	3-7-dimethoxy-5-chloro-acridine	.. Already described ..	(Kshatriya, Patel and Nargund loc. cit.)	....	....
3	3-7-dimethoxy-acridine ..	$C_{15}H_{15}O_2N$	by reduction of 3-7-dimethoxy-acridone by sodium and amyl alcohol. sublimes. sparingly sol in methyl and ethyl alcohol. shows faint bluish fluorescence in alcoholic solution.	C, 74.7 H, 6.4	C, 74.7 H, 6.2
4	3-7-dimethoxy-acridine ..	$C_{15}H_{13}O_2N$	from compound 3 by oxidation with aqueous methyl alcoholic ferric chloride. long needles from alcohol m.p. 195. shows green fluorescence in alcoholic solution.	C, 75.2 H, 5.6	C, 75.3 H, 5.4
5	3-7-dimethoxy acridine-picrate	$C_{21}H_{16}O_9N_4$	from compound 4 and picric acid in alcoholic solution. crystallises from hot water m.p. 242.	C, 53.6 H, 3.5	C, 53.9 H, 3.4
6	3-7-dimethoxy-5-phenoxy acridine	$C_{21}H_{17}O_3N$	from compound 2 by heating with phenol. very sol in ether and acetic acid and sparingly sol in alcohol and benzene. crystallises in plates from alcohol. m.p. $151-152^\circ$.	C, 75.9 H, 5.2	C, 76.1 H, 5.1
7	3-7-dimethoxy-5-amino-acridine hydrochloride.	$C_{15}H_{15}O_2N_2Cl$	from compound 2 and ammonium carbonate at 80° cooled, ether added and HCl passed. It crystallised from alcohol m.p. 290-291.	Cl, 12.4	Cl, 12.2
8	3-7-dimethoxy-5-amino-acridine	$C_{15}H_{14}O_2N_2$	from compound 7 with 10 percent aqueous ammonia. crystallised from alcohol m.p. 259-260. shows intense green fluorescence in acetic acid solution.	C, 70.6 H, 5.6	C, 70.8 H, 5.5

9	3-7-dimethoxy-5-phenyl amino acridine hydrochloride.	$C_{21}H_{19}O_2N_3Cl$	.. from compound 2 and aniline. red needle shaped crystals from alcohol m.p. 291 with decomposition.	Cl, 9.9	Cl, 9.7
10	3-7-dimethoxy-5-phenyl amino acridine	$C_{21}H_{18}O_2N_2$	.. from compound 9 and ten per cent. aqueous ammonia. yellow shining plates from alcohol m.p. 231.	C, 76.0 H, 5.6	C, 76.3 H, 5.5
11	3-7-dimethoxy-5-p-methoxy phenyl amino acridine-hydrochloride.	$C_{22}H_{21}O_3N_2Cl$	.. from compound 2 and p-anisidine purified by dissolving in alcohol and adding ether. m.p. 281 with decomposition.	Cl, 9.1	Cl, 8.9
12	3-7-dimethoxy-5-p-methoxy phenyl amino acridine.	$C_{22}H_{20}O_3N_2$	.. from compound 11 and ten per cent. aqueous ammonia. shining yellow plates from 50 per cent. alcohol. m.p. 194-195. shows intense green fluorescence in alcoholic solution.	C, 73.0 H, 5.7	C, 73.3 H, 5.5
13	3-7-dimethoxy-5-(p-diethyl phenyl) amino acridine dihydrochloride.	$C_{25}H_{29}O_2N_3Cl_2$	.. from compound 2 and p-amino diethyl aniline yellow powder purified by dissolving in alcohol and precipitating by ether m.p. 244.	Cl, 15.2	Cl, 15.0
14	3-7-dimethoxy-5-(p-diethyl phenyl) amino acridine.	$C_{25}H_{27}O_2N_3$	.. from compound 13 and ten per cent. ammonia. red shining plates from dilute alcohol m.p. 210-211 with decomposition showed strong green fluorescence in alcoholic solution.	C, 74.5 H, 6.9	C, 74.8 H, 6.7
15	3-7-dimethoxy-5-p-chlorophenyl amino acridine hydrochloride.	$C_{21}H_{18}O_2N_2Cl_2$	.. from compound 2 and p-chloro aniline. yellow shining needles from alcohol m.p. 294-295.	Cl, 18.1	Cl, 17.7
16	3-7-dimethoxy-5-p-chloro phenyl amino acridine.	$C_{21}H_{17}O_2N_2Cl$	.. from compound 15 and aqueous ammonia. shining yellow needles from aqueous alcohol. m.p. 209-210.	Cl, 9.9	Cl, 9.7
17	3-7-dimethoxy-5-m-chloro phenyl amino acridine hydrochloride.	$C_{21}H_{18}O_2N_2Cl_2$	.. from compound 2 and m-chloro aniline. yellow shining crystals from alcohol m.p. 310-311.	Cl, 17.9	Cl, 17.7

No.	Name of the Compound	Formula	Preparation and Properties	Analysis	
				Found	Required for
18	3-7-dimethoxy-5-m-chloro phenyl amino acridine.	$C_{21}H_{17}O_2N_2Cl$	from compound 17 and ammonia greenish yellow needles from aqueous alcohol m.p. 99-200.	Cl, 10.0	Cl, 9.7
19	3-7-dimethoxy-5-p-tolyl amino acridine hydrochloride.	$C_{22}H_{21}O_2N_2Cl$	from compound 2 and p-toluidine. m.p. 262	Cl, 9.8	Cl, 9.3
20	3-7-dimethoxy-5-p-tolyl amino acridine	$C_{22}H_{20}O_2N_2$	from compound 19 and ammonia shining yellow plates from aqueous alcohol m.p. 209-210.	C, 76.6 H, 5.9	C, 76.7 H, 5.8
21	3-7-dimethoxy-5-(β piperidino ethyl) amino acridine-di-hydrochloride.	$C_{22}H_{29}O_2N_3Cl_2$	from compound 2 and β piperidino ethyl amine. yellow plates from alcohol m.p. 276.	Cl, 16.4	Cl, 16.2
22	3-7-dimethoxy-5-piperidino ethyl amino acridine.	$C_{22}H_{27}O_2N_3$	from compound 21 and ammonia crystallised from alcohol m.p. 144.	C, 72.0 H, 7.5	C, 72.3 H, 7.4
23	Acid chloride of 4-4' dimethoxy-3'-chloro diphenyl-amine-2-carboxylic acid.	$C_{15}H_{13}O_3NCl_2$	from the acid of Kshatriya, Patel and Nar-gund. loc. cit. and thionyl chloride in petrol. Long yellow needles from petrol m.p. 102.	Cl, 21.9	Cl, 21.8
24	Ethyl 4-4'-dimethoxy-3' chloro diphenyl amine-2-carboxylate.	$C_{17}H_{18}O_4NCl$	from compound 23 and ethyl alcohol needles from alcohol m.p. 92.	Cl, 10.7	Cl, 10.6
25	3-7-dimethoxy-5-8-dichloro acridine	$C_{15}H_{11}O_2NCl_2$	from 4-4' dimethoxy-3'-chlorodiphenyl amine-2-carboxylic acid and $POCl_3$ along with compound Nc. 38 crystallises first from toluene also prepared from compound 28 and $POCl_3$ m.p. 198.	Cl, 23.1	Cl, 23.0
26	2-4-dichloro-5-methoxy-toluene	$C_8H_8OCl_2$	from m-cresol methyl ether and chlorine in boiling. b.p. 254 at 755 mm. $D_{43}^{25} = 1.055$ $N_d^{25} = 1.5599$.	Cl, 37.3	Cl, 37.2

27	2,4-dichloro-5-methoxy-benzoic acid . .	$C_8H_6O_3Cl_2$	..	from compound 26 by oxidation by $KMnO_4$. colourless long needles from alcohol m.p. 190.	Cl, 32·2 Eqt, wt, 223	Cl, 32·1 Eqt, wt, 221
28	4,4'-dimethoxy-3-chloro-diphenyl amine-2-carboxylic acid.	$C_{15}H_{14}O_4NCl$	..	from compound 27 and p-anisidine by Ullmanns reaction. yellow needles from alcohol. m.p. 206.	Cl, 11·7 Eqt, wt, 311	Cl, 11·5 Eqt, wt, 308
29	3,7-dimethoxy-8-chloro-5-phenoxy acridine.	$C_{21}H_{16}O_3NCl$	..	from compound 25 and phenol at 80 pale yellow flat needle from alcohol m.p. 167.	Cl, 9·8	Cl, 9·7
30	3,7-dimethoxy-8-chloro-5-amino. acridine hydrochloride.	$C_{15}H_{14}O_2N_2Cl_2$	2	from compound 25 and ammonium carbonate, yellow flat needles from alcohol in which it was sparingly sol in hot. m.p. above 350.	Cl, 21·9	Cl, 21·8
31	3,7-dimethoxy-8-chloro-5-amino acridine.	$C_{15}H_{13}O_2N_2Cl$	..	from compound 30 and ammonia yellow needles from alcohol. m.p. 300 with decomposition.	Cl, 12·4	Cl, 12·3
32	3,7-dimethoxy-8-chloro-5-phenyl amino acridine-hydrochloride.	$C_{21}H_{17}O_2N_2Cl_2$	2	from compound 25 and aniline red needles from alcohol. m.p. 278 with decomposition.	Cl, 17·8	Cl, 17·7
33	3,7-dimethoxy-8-chloro-5-phenyl amino acridine.	$C_{21}H_{17}O_2N_2Cl$	..	from compound 32 and aqueous ammonia. greenish yellow needles from dilute alcohol. m.p. 211.	Cl, 9·8	Cl, 9·7
34	3,7-dimethoxy-8-chloro-5-p-chlorophenyl amino acridine hydrochloride.	$C_{21}H_{17}O_2N_2Cl_3$	3	from compound 25 and p-chloro aniline. red crystals from alcohol m.p. 295 with decomposition.	Cl, 24·6	Cl, 24·2
35	3,7-dimethoxy-8-chloro-5-p-chlorophenyl amino acridine.	$C_{21}H_{16}O_2N_2Cl_2$	2	from compound 34 and aqueous ammonia. yellow wooly needles from alcohol m.p. 231.	Cl, 17·9	Cl, 17·8
36	3,7-dimethoxy-8-chloro-5-(β piperidino-3-thyl) amino acridine dihydrochloride.	$C_{22}H_{28}O_2N_3Cl_3$	3	from compound 25 and β piperidino ethyl amine. deep yellow powder from alcohol ether mixture. m.p. 245-246.	Cl, 23·6	Cl, 23·2
37	3,7-dimethoxy-8-chloro-5-(β piperidino-3-thyl) amino-acridine.	$C_{22}H_{26}O_2N_3Cl$	..	from compound 36 and aqueous ammonia. flat yellow needles m.p. 125.	Cl, 9·1	Cl, 8·9

No.	Name of the Compound	Formula	Preparation and Properties	Analysis	
				Found	Required for
38	3-7-dimethoxy-5-6-dichloro-acridine ..	$C_{15}H_{11}O_2NCl_2$..	second fraction from toluene in the preparation of compound 25. yellow wooly needles m.p. 162.	Cl, 23.1	Cl, 23.0
39	3-7-dimethoxy-6-chloro-acridine ..	$C_{15}H_{11}O_3NCl$..	from compound 38 by boiling with dilute alkali does not melt below 350.	Cl, 12.4	Cl, 12.3
40	3-7-dimethoxy-5-phenoxy-6-chloro-acridine.	$C_{21}H_{16}O_3NCl$..	from compound 38 and phenol. pale yellow needles from alcohol m.p. 157-158.	Cl, 9.9	Cl, 9.7
41	3-7-dimethoxy-6-chloro-5-phenylamino acridine hydrochloride.	$C_{21}H_{18}O_2N_2Cl_2$	from compound 38 and aniline. red needles from alcohol m.p. 276.	Cl, 17.8	Cl, 17.7
42	3-7-dimethoxy-6-chloro-5-phenylamino acridine.	$C_{21}H_{17}O_2N_2Cl$..	from compound 43 and aqueous ammonia. m.p. 201.	Cl, 9.8	Cl, 9.7
43	3-7-dimethoxy-6-chloro-5-(β piperidino ethyl) amino acridine-dihydrochloride.	$C_{22}H_{28}O_2N_3Cl_3$	from compound 38 and β piperidino ethyl amine. yellow powder m.p. 242.	Cl, 23.4	Cl, 23.2
44	Acid chloride of 4'-methoxy-3,3'-dichlorodiphenyl amine-6-carboxylic acid.	$C_{14}H_{10}O_2NCl_3$..	from the corresponding acid and thionyl chloride m.p. 126.	Cl, 32.3	Cl, 32.2
45	Methyl-4'-methoxy-3,3'-dichlorodiphenyl amine-6-carboxylate.	$C_{15}H_{13}O_3NCl_2$..	from compound 46 and methyl alcohol. long colourless needles m.p. 104.	Cl, 21.9	Cl, 21.8
46	Ethyl-4'-methoxy-3,3'-dichlorodiphenyl amine-6-carboxylate.	$C_{16}H_{15}O_3NCl_2$..	from compound 46 and ethyl alcohol. m.p. 106.	Cl, 21.3	Cl, 20.9
47	2-5-8-trichloro-7-methoxy acridine ..	$C_{14}H_8ONCl_3$..	from 4'-methoxy-3,3'-dichlorodiphenylamine-6-carboxylic acid and $POCl_3$ along with the second isomer compound 63. bright yellow needles from toluene m.p. 209.	Cl, 34.1	Cl, 34.1

48	2-8-dichloro-7-methoxy-acridone	$C_{14}H_9O_2NCl_2$	from compound 49 by boiling with HCl and alcohol. no m.p.	Cl, 24.5
49	2-8-dichloro-7-methoxy-5-phenoxyacridine.	$C_{20}H_{13}O_2NCl_2$	from compound 49 and phenol yellow light flakes from alcohol. shows violet fluorescence in alcoholic sol greenish blue in H_2SO_4 . m.p. 165-166.	Cl, 19.2
50	2-8-dichloro-7-methoxy-5-aminoacridine hydrochloride.	$C_{14}H_{11}ON_2Cl_3$	from compound 49 and ammonium carbonate. no m.p.	Cl, 32.3
51	2-8-dichloro-7-methoxy-5-aminoacridine.	$C_{14}H_{10}ON_2Cl_2$	from compound 52 and aqueous ammonia. yellow needles from aqueous alcohol m.p. 286.	Cl, 24.2
52	2-8-dichloro-7-methoxy-5-phenylaminoacridine hydrochloride.	$C_{20}H_{15}ON_2Cl_3$	from compound 49 and aniline saffron coloured feathery flakes from alcohol m.p. 280-282.	Cl, 26.2
53	2-8-dichloro-7-methoxy-5-phenylaminoacridine.	$C_{20}H_{14}ON_2Cl_2$	from compound 54 and aqueous ammonia. yellow needles from aqueous alcohol m.p. 199-200.	Cl, 19.2
54	2-8-dichloro-7-methoxy-5-p-chlorophenyl aminoacridine hydrochloride.	$C_{20}H_{14}ON_2Cl_4$	from compound 49 and p-chloro aniline. yellow needle m.p. 296.	Cl, 32.3
55	2-8-dichloro-7-methoxy-5-p-chlorophenyl aminoacridine.	$C_{20}H_{13}ON_2Cl_3$	from compound 56 and aqueous ammonia. needles m.p. 184.	Cl, 26.2
56	2-8-dichloro-7-methoxy-5-p-methoxyphenyl aminoacridine hydrochloride.	$C_{21}H_{17}O_2N_2Cl_3$	from compound 49 and p anisidine m.p. 287.	Cl, 24.5
57	2-8-dichloro-7-methoxy-5-p-methoxyphenyl aminoacridine.	$C_{21}H_{16}O_2N_2Cl_2$	from compound 58 and aqueous ammonia. reddish yellow needles m.p. 141.	Cl, 17.8
58	2-8-dichloro-7-methoxy-5 (p-diethylamino phenyl) aminoacridine dihydrochloride.	$C_{24}H_{25}ON_3Cl_4$	from compound 49 and (p-amino diethyl) aniline. m.p. 235 with decomposition.	Cl, 27.6

No.	Name of the Compound	Formula	Preparation and Properties	Analysis	
				Found	Required for
59	2-8-dichloro-7-methoxy-5-(β piperidino ethyl) amino acridine dihydrochloride.	$C_{21}H_{25}ON_3Cl_4$	from compound 49 and (β piperidino ethyl) amine, no m.p.	Cl, 29.8	Cl, 29.8
60	2-8-dichloro-7-methoxy-5-(β piperidino ethyl) amino acridine.	$C_{21}H_{23}ON_3Cl_2$	from compound 61 and ammonia bright yellow needles m.p. 178.	Cl, 17.7	Cl, 17.5
61	2-5-6-trichloro-7-methoxy acridine	$C_{14}H_8ONCl_3$	see the preparation of compound 49, separated by fractional crystallisation from toluene from 49, m.p. 181.	Cl, 34.1	Cl, 34.1
62	2-6-dichloro-7-methoxy-5-phenoxyacridine.	$C_{20}H_{13}O_2NCl_2$	from compound 63 and phenol small needles m.p. 147.	Cl, 19.2	Cl, 19.2
63	2-6-dichloro-7-methoxy-5 amino acridine hydrochloride.	$C_{14}H_{11}ON_2Cl_3$	from compound 63 and ammonium carbonate, saffron coloured needles m.p. 337.	Cl, 32.4	Cl, 32.3
64	2-6-dichloro-7-methoxy-5-amino acridine.	$C_{14}H_{10}ON_2Cl_2$	from compound 65 and ammonia tiny yellow needles m.p. 135.	Cl, 24.3 per cent	Cl, 24.2
65	acid chloride of 3'-chloro-4'-methoxy diphenyl amine-2-carboxylic acid.	$C_{14}H_{11}O_2NCl_2$	from the corresponding acid and thionyl chloride crystallised from petrol m.p. 123-124.	Cl, 24.2	Cl, 23.9
66	Methyl 3'-chloro-4'-methoxy diphenyl amine-2-carboxylate.	$C_{15}H_{14}O_3NCl$	from compound 67 and methyl alcohol m.p. 87.	Cl, 12.2	Cl, 12.2
67	Ethyl 3'-chloro-4'-methoxy-diphenyl amine-2-carboxylate.	$C_{16}H_{16}O_3NCl$	from compound 67 and ethyl alcohol m.p. 118.	Cl, 11.4	Cl, 11.6
68	amide of 3-chloro-4-methoxy diphenyl amine-2-carboxylic acid.	$C_{14}H_{13}O_2N_2Cl$	from compound 67 and ammonia needles m.p. 110.	Cl, 12.7	Cl, 12.8

69	5-8-dichloro-7-methoxy acridine	$C_{14}H_9ONCl_2$	..	from 3'-chloro-4'-methoxy dihenyl amine-2-carboxylic acid and $POCl_3$ and also from compound 72 and $POCl_3$ crystallised from toluene m.p. 198.	Cl, 25.3	Cl, 25.6
70	5-chloro-4-methoxy diphenyl amine-2-carboxylic acid.	$C_{14}H_{12}O_3NCl$	..	from compound 27 and aniline by Ullmann's reaction. yellowish green needles from alcohol m.p. 184-185.	Cl, 12.7 Eqt, wt, 276	Cl, 12.8 Eqt, wt, 277
71	8-chloro-7-methoxy-5-phenoxyacridine	$C_{20}H_{14}ONCl$	..	from compound 71 and phenol yellow needles from aqueous alcohol m.p. 159-160.	Cl, 10.3	Cl, 10.6
72	8-chloro-7-methoxy-5-amino acridine hydrochloride.	$C_{14}H_{12}ON_2Cl_2$	..	from compound 71 and ammonium carbonate. m.p. 320.	Cl, 23.9	Cl, 24.1
73	8-chloro-7-methoxy-5-amino acridine..	$C_{14}H_{11}ON_2Cl$	..	from compound 74 and aqueous ammonia brick red needles m.p. 279.	Cl, 13.5	Cl, 13.7
74	8-chloro-7-methoxy-5-phenyl amino acridine hydrochloride.	$C_{20}H_{16}ON_2Cl_2$	..	from compound 71 and aniline m.p. 285-286.	Cl, 19.0	Cl, 19.1
75	8-chloro-7-methoxy-5-phenyl amino acridine.	$C_{20}H_{15}ON_2Cl$	..	from compound 76 and aqueous ammonia. yellowish brown needles from aqueous alcohol m.p. 200-203.	Cl, 10.4	Cl, 10.6
76	8-chloro-7-methoxy-5-p chlorophenyl amino acridine hydrochloride.	$C_{20}H_{15}ON_2Cl_3$	..	from compound 71 and p-chloro aniline m.p. 275.	Cl, 26.1	Cl, 26.3
77	8-chloro-7-methoxy-5-p chlorophenyl amino acridine.	$C_{20}H_{14}ON_2Cl_2$	..	from compound 78 and aqueous ammonia m.p. 210.	Cl, 19.2	Cl, 19.2
78	8-chloro-7-methoxy-5-p methoxy phenyl amino acridine hydro chloride.	$C_{21}H_{18}O_2N_2Cl_2$	..	from compound 71 and p-anisidine m.p. 264.	Cl, 17.5	Cl, 17.7
79	8-chloro-7-methoxy-5-(m chloro p-methoxy phenyl) amino acridine hydrochloride.	$C_{21}H_{17}O_2N_2Cl_3$	..	from compound 71 and m chloro p-methoxy aniline. deep yellow needles m.p. 281.	Cl, 24.3	Cl, 24.4

No.	Name of the Compound	Formula	Preparation and Properties	Analysis	
				Found	Required for
80	8-chloro-7-methoxy-5-(p diethyl amino phenyl) amino acridine dihydrochloride.	$C_{24}H_{26}ON_3Cl_3$	.. from compound 71 and p amino diethyl ani- line m.p. 257 with decomposition. Cl, 22.0	Cl, 22.3	
81	8-chloro-7-methoxy-5-(β piperidino ethyl) amino acridine dihydrochloride.	$C_{21}H_{26}ON_3Cl_3$	.. from compound 71 and β piperidino amine, yellow needles from aqueous alcohol m.p. 355. Cl, 24.1	Cl, 24.1	
82	8-chloro-7-methoxy-5-(β ethyl) amino acridine.	$C_{21}H_{24}ON_3Cl$	.. from compound 83 and aqueous ammonia, brownish yellow needles m.p. 310. Cl, 9.6	Cl, 9.6	
83	Acid chloride of 3-3'-dichloro diphenyl amine-6-carboxylic acid.	$C_{13}H_8ONCl_3$	.. from the acid (Kshatriya, Patel and Nargund loc. cit.) and thionyl chloride m.p. 99. Cl, 35.4	Cl, 35.4	
84	Methyl-3-3-dichloro-diphenyl amine-6-carboxylate.	$C_{14}H_{11}O_2NCl_2$	.. from compound 85 and methyl alcohol m.p. 66-67. Cl, 24.0	Cl, 24.0	
85	2-5-8-trichloro acridine	$C_{13}H_6NCl_3$	.. from the corresponding acid and POCl ₃ m.p. 223. Cl, 37.7	Cl, 37.7	
86	2-8-dichloro acridone	$C_{13}H_7ONCl_2$	.. from compound 87 boiling with dilute hydrochloric acid. m.p. higher than 350. Cl, 26.9	Cl, 26.9	
87	2-8-dichloro-5-phenoxy acridine	$C_{19}H_{11}ONCl_2$.. from compound 87 and phenol yellow needles m.p. 176. Cl, 20.9	Cl, 20.9	

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DERIVATIVES OF 3-CHLORO AND 3-iodo PHTHALIC ACIDS

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IN connection with another work we had to prepare considerable quantities of 3-chloro and 3-iodo phthalic acids. As only few derivatives of these are at present known it was thought worthwhile to prepare the common derivatives, so that these acids can be well characterised. Bogert and Boroschek (J. A. C. S. 1901, 740) have described in detail the methods of preparation of derivatives of 3-nitro phthalic acid. We have used the same methods in this work and the derivatives are described below.

Name of the Compound	Formula	Preparation and Properties	Analysis	
			Found per cent	Required per cent
3-chloro phthalimide	$C_8H_4O_2NCl$	By heating the acid at its m.p. in a current of dry NH_3 needles from aqueous alcohol m.p. 230.	Cl, 20.3	Cl, 19.6
2-carbethoxy-6-chloro benzoic acid.	$C_{10}H_9O_4Cl$	By heating the acid with alcohol saturated with dry HCl long flat needles from hot water m.p. 125.	Eqt, wt, 229	Eqt, wt, 228
2-carbethoxy-3-chloro benzoic acid.	$C_{10}H_9O_4Cl$	By heating the anhydride with the requisite quantity of absolute alcohol plates from water m.p. 138.	Eqt, wt, 232	Eqt, wt, 228
Diethyl-3-chloro phthalate.	$C_{12}H_{13}O_4Cl$	By heating the silver salt with ethyl iodide long flat needles from aqueous alcohol m.p. 48.	Cl, 13.3	Cl, 13.8
2-carbanilido-6-chlorobenzoic acid.	$C_{14}H_{10}O_3NCl$	From the anhydride equivalent quantity of aniline, needles from alcohol m.p. 160.	Eqt, wt, 281	Eqt, wt, 275
Acid aniline salt of 3-chloro phthalic acid.	$C_{14}H_{12}O_4NCl$	From the acid and aniline in alcohol flat needles from alcohol m.p. 160 with effervescence.	Cl, 11.7	Cl, 12.0

Name of the Compound	Formula	Preparation and Properties	Analysis	
			Found per cent	Required per cent
3-chloro-phthalanil	$C_{14}H_9O_2NCl$	By heating the aniline salt at its m.p. needles from alcohol m.p. 188.	Cl, 11.6	Cl, 11.2
Acid o-toluidine salt of 3-chloro phthalic acid.	$C_{15}H_{14}O_4NCl$	From the acid and o-toluidine needles from alcohol m.p. 161 with effervescence.	Cl, 13.2	Cl, 13.2
3-chloro phthal o-toluil.	$C_{15}H_{10}O_2NCl$	Needles from alcohol m.p. 165.	Cl, 13.0	Cl, 13.1
2-carbethoxy-6-iodo benzoic acid.	$C_{10}H_9O_4I$	Pale yellow needles from hot water m.p. 132.	Eqt, wt, 322.0	Eqt, wt, 320.0
2-carbethoxy-3-iodo benzoic acid.	$C_{10}H_9O_4I$	Needles from benzene m.p. 128. Mixed m.p. with the above isomeric compound 110.	Eqt, wt, 320.0	Eqt, wt, 320.0
2-carbanilido-6-iodo benzoic acid.	$C_{14}H_{10}O_3NI$	Long needles from aqueous alcohol m.p. 155 with effervescence.	Eqt, wt, 372	Eqt, wt, 367
Acid aniline salt of 3-iodo phthalic acid.	$C_{14}H_{12}O_4NI$	Needles from alcohol m.p. 180 with effervescence.	I, 31.9	I, 32.7
3-iodo phthalanil	$C_{14}H_8O_2NI$	Light green needles from alcohol m.p. 172.	I, 37.2	I, 36.4
Acid o-toluidine salt of 3-iodo phthalic acid.	$C_{15}H_{14}O_4NI$	Needles from benzene m.p. 164 with effervescence.	I, 31.2	I, 32.8
3-iodo phthal o-toluil	$C_{15}H_{10}O_2NI$	Plates from benzene alcohol mixture m.p. 185.	I, 35.2	I, 35.0
Acid p-toluidine salt of 3-iodo phthalic acid.	$C_{15}H_{14}O_4NI$	Needles from alcohol m.p. 175 with effervescence.	I, 31.5	I, 31.8
3-iodo-phthal p-toluil.	$C_{15}H_{10}O_2NI$	Needles from benzene m.p. 184.	I, 35.4	I, 35.0

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SUBSTITUTED DIPHENYL-AMINE-CARBOXYLIC ACIDS

By G. D. SHAH AND K. S. NARGUND

IN connection with study of anti-malarials in the acridine series we wanted to make an intensive study of the effect of OCH_3 , NO_2 , and Cl groups present as substituents in the acridine nucleus the rest of the molecule remaining the same as in atabrine. We have kept these groups in the position in which they have been shown to have the maximum effect. For example OCH_3 has the effect when present in para position, NO_2 group in para and Cl in meta position to the ring nitrogen of the acridine nucleus. Keeping these orientations we have prepared the diphenyl amine carboxylic acids described below so that they could be later cyclised to a chloro acridine and the side chain attached and the anti-malarial property of the resulting acridine compound studied.

4-4'-dinitro diphenyl amine-2-carboxylic acid (Bogert and Hirschfelder (czech. chem. comm. 1930, 2, 383) 3'-chloro-4-nitro diphenyl amine-2-carboxylic acid (Bradbury and Linnell J. C. S. 1942, 379) and 5-chloro-4'-nitro diphenyl amino-2-carboxylic acid (Aggarwal, Sen Gupta and Ahmad Jou. Ind. Che. Soc. 1945, 42) are already known. But the yields of these acids were poor, and nothing beyond their m. p. was recorded. We have improved their yields and characterised them by the preparation of the acid chloride, methyl and ethyl esters. We have prepared the following acids as well.

2-4-dichloro-5-nitro benzoic acid on condensation with aniline gave 5-chloro-4-nitro diphenyl amine-2-carboxylic acid m. p. 240. Similarly 2-4-dichloro-5-nitro benzoic acid and meta-chloro-aniline gave 3-3'-dichloro-4-nitro diphenyl-amine-2-carboxylic acid m. p. 253-254. 2-4-dichloro-5-methoxy benzoic acid and p nitraniline gave 3-chloro-4-methoxy-4'-nitro diphenyl-amine-2-carboxylic acid m. p. 251. All these acids formed almost insoluble potassium salts and this fact was used in their isolation and purification.

EXPERIMENTAL

General method for the preparation of diphenyl-amine-2-carboxylic acids :—

Substituted o-chloro benzoic acid (0.1 mol) and freshly fused potassium carbonate (0.1 mol) were suspended in amyl alcohol (50 cc) containing benzene (10 cc.) It was heated for half an hour and benzene and part of the amyl alcohol were distilled off to obtain dry potassium salt. Then the requisite quantity of the aryl-amine and a trace of copper powder were added and heated in oil bath at 140-150 for 3-5 hours. About 50 cc. of water was then added and steam distilled to remove amyl alcohol and filtered hot. The filtrate on cooling deposited the potassium salt of the diphenyl amine acid. It was filtered and decomposed by 5 N hydrochloric acid. The acid thus obtained was filtered, washed and dried.

Acid chloride of 4-4'-dinitro diphenyl-amine-2-carboxylic acid : The acid (Bogert and Hirschfelder *loc. cit.*) (0.5 gms.) and thionyl chloride (5 cc.) were heated together till the acid went into solution. Excess of thionyl chloride was removed under vacuum and the residue was crystallised from benzene in stout needles m. p. 196 (Found Cl, 11.8 per cent $C_{13}H_8O_5N_3Cl$ requires Cl, 11.0 per cent) *Methyl 4-4'-dinitro-diphenyl-amine-2-carboxylate* prepared from the above acid chloride and methyl alcohol crystallised from methyl alcohol-benzene mixture in needles m.p. 220 (Found C, 53.2 H, 3.6 per cent $C_{14}H_{11}O_6N_3$ requires C, 53.0 H, 3.4 per cent) *Ethyl ester* similarly prepared crystallised from ethyl alcohol in needles m. p. 167 (Found Cl, 51.7 H, 4.1 per cent $C_{15}H_{13}O_5N_3$ requires C, 54.3 H, 3.9 per cent.)

Acid chloride of 3'-chloro-4-nitro-diphenyl amine-2-carboxylic acid. It was prepared from the acid (Bradbury and Linnell, *loc. cit.*) and thionyl chloride and crystallised from benzene in needles m.p. 171. (Found Cl, 23.1 per cent $C_{13}H_8O_3N_2Cl_2$ requires Cl, 22.8 per cent.) *Methyl ester* of this acid crystallised from methyl alcohol and had m. p. 123 (Found Cl, 11.9 per cent. $C_{14}H_{11}O_4N_2Cl$ requires Cl, 11.5) *The ethyl ester* of the acid had m. p. 108 (Found Cl, 11.3 per cent $C_{15}H_{13}O_4N_2Cl$ requires Cl, 11.1 per cent.)

Acid chloride of 5-chloro-4'-nitro diphenyl amine-2-carboxylic acid prepared from the acid (Aggarwal, Sen Gupta and Ahmad *loc. cit.*) and thionyl chloride crystallised from benzene petrol mixture and had m. p. 159 (Found Cl, 23.0 $C_{13}H_8O_3N_2Cl_2$ requires Cl, 22.8 per cent). The *methyl ester* had m. p. 163-164 (Found Cl, 11.9 per cent. $C_{14}H_{11}O_4N_2Cl$ requires Cl, 11.6 per cent.) The *ethyl ester* had m.p. 138 (Found Cl, 11.6 per cent $C_{15}H_{13}O_4N_2Cl$ requires Cl, 11.1 per cent.)

5-chloro-4-nitro diphenyl amine 2-carboxylic acid :—The yield of this acid was one gram from 2.3 gms. of 2-4-dichloro-5-nitro benzoic acid, 1.3 gms. of K_2CO_3 and aniline 1.5 gms. It was soluble in hot alcohol, and acetic acid and sparingly soluble in benzene and insoluble in petrol. It crystallised best from acetic acid m. p. 240 potassium, ammonium and sodium salts crystallised from hot water while lead and silver salts were insoluble in water. (Found Cl, 12.3 per cent. Eqt. wt. 295 $C_{13}H_9O_4N_2Cl$ requires Cl, 12.1 and eqt. wt. 292.5).

3'-5-dichloro-4-nitro diphenyl amine-2-carboxylic acid :—The yield of this acid was only 0.5 gms from 2.3 gms of 2-4-dichloro-5-nitro benzoic acid. It was soluble in hot alcohol and acetic acid slightly in hot benzene m. p. 253-254. Calcium, Barium and potassium salts were soluble in hot water and crystallised on cooling while lead and silver salts were insoluble in water. (Found Cl, 22.0 per cent Eqt. wt. 329. $C_{13}H_8O_4N_2Cl_2$ requires Cl, 21.7 per cent eqt. wt. 327).

5-chloro-4-methoxy-4'-nitro diphenyl amine-2-carboxylic acid :—The yield of this acid was 1.2 gms from 2 gms of 2-4-dichloro-5-methoxy benzoic acid. It crystallised in clusters of needles from acetic acid in which it was soluble in hot. It was also soluble in hot alcohol but sparingly soluble in benzene and insoluble in petrol. Ca, Ba, Pb and Ag salts were insoluble in water potassium and ammonium salts crystallised from hot water (Found Cl, 11.4 per cent Eqt. wt. 316 $C_{14}H_{11}O_5N_2Cl$ requires Cl, 11.0 per cent. eqt. wt. 322.5).

CRYOSCOPIC STUDIES IN SOME INDIAN EDIBLE OILS AND FATS

BY S. S. PHATAK, K. K. DOLE AND D. D. KARVE

DETERMINATION of molecular weights of vegetable and animal oils and fats by cryoscopic methods has been carried out by some workers as W. Norman (Chem. Zeit. 1907, 31, 211-214), Pailhart (Bull. Soc. Chem. 1909, 425), H. J. Backer (Chem. Weekblad, 1915, 12, 1034), J. S. Long and J. G. Smull (J. Ind. Eng. Chem. 1925, 138). All these workers have found out merely molecular weights of some oils and fats, but no exhaustive study was made. This work was therefore undertaken with a view to study the cryoscopic behaviour of some Indian oils and fats.

Plan of investigation—Various different physical and chemical values and the molecular weights of samples of oils or fats were studied in order to observe the relations between them and to find out the range of the molecular weights.

Experimental—Purification of substances.

Molecular weights of oils and fats were determined by using benzene as solvent. B. D. H. "Analar" Benzene was made thiophene-free by shaking it with concentrated sulphuric acid, drying over sodium and then distilling it. The portion between 77.3°C-77.6°C. at 72.1 cm. pressure was taken. The freezing point constant was calculated by using naphthalene as standard solute and was found to be 51.2.

About 1 gm. of oil or fat was accurately weighed in a freezing test-tube and 25 cc. of benzene was run down into it. The error in pipetting 25 cc. of benzene was determined to be 0.05%. The temperature of the outside bath was kept between 3°C. to 5°C. The freezing point was determined at least twice in each case or until several determinations agreed closely.

Selection of the concentration of the oil or the fat in the determination of its molecular weight by the cryoscopic method.

It was observed by W. Norman (Chem. Zeit: 1907, 31, 211-214) in his study of molecular weights of some oils and fats that high values of molecular weights of oils were obtained in dilute solutions of benzene and as the concentration increased the molecular weights were found to decrease.

In order to find out a suitable concentration of the oils and fats, it was necessary to find out the molecular weights at different concentrations of the solutes. A suitable concentration is that which does not give too small a depression. If the depression is too small then a very small error in the measurement of temperature gives rise to an appreciable error in the molecular weight. This error is enlarged in the case of oils and fats, since these possess high molecular weights.

0.5 to 4.0 grams of a freshly prepared sample of Ghee, possessing an acid value 0.2 were dissolved in 25 cc. of benzene, the depression in the freezing point observed and the molecular weights were calculated.

TABLE No. 1

25 cc. Benzene = 21.581 grams at temp. 26°C

Weight of Ghee taken in grms.	Depression in Freezing Point°C	Molecular Weight	% of Ghee in Solution
0.583	0.204	677	2.702
0.893	0.313	676	4.139
1.007	0.353	676.6	4.666
1.248	0.438	676	5.784
1.524	0.537	673	7.062
1.894	0.671	670	8.778
2.145	0.760	670	9.940
2.541	0.908	664	11.78
3.100	1.118	658	14.36
3.516	1.285	649	16.29
3.988	1.49	635	18.48

From the graph No. 1 and table No. 1 it will be observed that the curve between the points A and B is practically a straight line and then it begins to descend gradually, indicating that as the concentration of the solute is increased the molecular weight decreases. The concentrations corresponding to the portion A to B of the curve, therefore, are found to give most satisfactory results and were chosen for the present investigation. This concentration amounts to between 4 and 5.5 parts of the solute to 100 parts of the solvent. The quantity of ghee and oils used in the investigation varied from 0.950 to 1.050 grams in 25 cc. of benzene.

EXPERIMENTAL RESULTS

In the following table the molecular weights of some oils and fats, and of pure butter-fat (ghee) from different places, from different animals both stall and pasture fed, and at regular intervals throughout the year with some of their important values are given.

TABLE No. 2

Oil or Fat	Molecular Weight	B. R. at 40°C	R. M. Value	Sap. Value	Iodine No.
Buffalo-ghee (141 samples) ..	665-682	40.0-43.7	22-35	222-236	24-36
Acid value less than 2					
Cow-ghee (20 samples) ..	660-675	40.0-42.5	21-30.3	221-231	28-35
Acid value less than 2					
Arachis Oil ..	774-784	54.8-56.5	0.4-0.8	188-194	88-94
Hydrogenated Oils ..	776-782	51-52	0.2-0.3	191-192	61-64
Cotton seed Oil ..	815-818	57.8-58.5	0.2-0.4	190-195	105-110
Sesame Oil ..	824-833	59.3-60.2	0.1-0.3	186-193	101-108
Cocoonut Oil Acid value ..	602-610	34.5-35.5	6.5-7.4	251-257	6.5-9.0
less than 0.5					
Lard ..	775-778	51	0.4	195	41
Tallow ..	785	49	—	194	45

From the results obtained it can be seen clearly that there is a large difference between the molecular weights of ghee and other edible oils or fats which are generally used as adulterants of ghee. Further, the range of molecular weights for ghee is comparatively smaller than the range of other chemical and physical values. Therefore, it is quite possible to use this method for the detection and estimation of adulteration in ghee by some of its common adulterants.

Pure buffalo ghee was then mixed with different quantities of some of its common adulterants like cocoanut oil, hydrogenated oils, sesame oil and those mixtures were examined. The results obtained are given below :—

TABLE NO. 3
Mixture of Butter-fat and Vegetable Ghee

Percentage of Vegetable Ghee	Molecular Weight	B. R. at 40°C	R. M. Value	Saponification Value
10%	685	43.4	25.3	225
15%	691	43.8	24	223
20%	695	44.3	22.7	221.5
25%	700	44.72	21.4	219.7
30%	706	45.45	20.1	218
35%	710	45.87	18.7	216
40%	716	46.3	17.5	214.3
50%	725	47.75	14.9	210
Butter-fat (Acid value 0.73)	675	42.5	28	228
Vegetable Ghee ..	775	51	0.7	192

TABLE NO. 4
Mixture of Butter-fat and Sesame Oil

Percentage of Sesame Oil	Molecular Weight	B. R. at 40°C	R. M. Value	Saponification Value
10%	691	44.2	25.4	225
15%	699	45	24.1	223
20%	707	45.8	22.8	221
25%	715	46.66	21.6	219
Butter Fat ..	676	42.5	28.3	228
Sesame Oil ..	832	59.2	0.43	189

TABLE NO. 5
Mixture of Butter-fat and Cocoanut Oil

Percentage of Cocoanut Oil	Molecular Weight	B. R. at 40°C	R. M. Value	Saponification Value
10%	668	41.9	26	231
15%	664	41.5	25.1	233
20%	662	41.1	23.9	234.8
25%	658	40.8	22.93	235
30%	654	40.5	21.8	237
35%	651	40.1	20.7	238
40%	648	39.8	19.6	239.9
50%	640	39.0	17.5	242
Butter-fat (Acid value 0.73)	675	42.5	28	228
Cocoanut Oil (Acid value 0.8)	603	35.5	7.04	255

With reference to the analysis of samples of Ghee having high acid values, low molecular weights are observed.

The results of a few such samples of ghee are given in the following table.

TABLE NO. 6

Sample No.	Molecular Weight	Acid Value	B. R. at 40°C	R. M. Value	Saponification Value	Iodine No.
1	647	9.964	43.01	30	233.8	31.25
2	640	8.91	42.8	28.5	230	29.3
3	638	6.85	42	28.4	230	29.4
4	643	6.3	41.9	29	232	30.72
5	646	6.8	41.9	27.3	228	33.8
6	642	4.75	40.9	27.2	227	32.4
7	639	10.7	42.8	30.1	233	28.2
8	645	5.8	42.3	27.1	229	29.5
9	643	6.1	42	25.9	228	30.3
10	635	15.6	43.5	28.1	231	28.4
11	640	4.98	41.5	29	229	30.1
12	641	5.72	42.5	29.3	228	28.6

Since in pure ghee acidity does not increase rapidly as in the case of butter, samples of freshly prepared butter were spread on the surface of a flat dish and exposed to air. Portions were removed at different intervals of time and were converted into ghee and acid-rancidity was estimated. The results of acid value and molecular weights of these samples are given in the following table.

STUDY OF ACID RANCIDITY

TABLE NO. 7

Sample No. 1

Period	Acid Value	Molecular Weight	B. R. at 40°C	R. M. Value	Saponification Value	Iodine No.
Starting day ..	0.201	676	42.5	28.01	232	28.75
After 1 ,, ..	0.912	676	42.5	28.1	232	28.75
After 2 days ..	1.82	674	42.6	28.3	232	28.34
After 3 ,, ..	3.63	673	42.6	28.5	233	28.07
After 4 ,, ..	7.22	650	42.9	28.99	234	27.5
After 5 ,, ..	7.96	649	43.01	28.9	234	27.3
After 12 ,, ..	16.41	646	43.5	30	235	26.3
After 14 ,, ..	20.23	644	43.7	30.1	235	26.1
After 20 ,, ..	29.7	642	44.0	31.0	237	25.9

It is clear that these high acid values are due to the presence of free fatty acids in the butter. In that case it should be possible to regain the original molecular weight of butter-fat by removing the free fatty acids, by washing the butter-fat thoroughly, first with dilute sodium hydroxide solution and then with water and drying the butter-fat over anhydrous calcium chloride. The molecular weights of the samples were then determined.

TABLE No. 8

Original molecular weights (before increase in the acid value) of the samples given in this table were unknown—

Sample No.	Molecular Weight	Acid Value	B. R. at 40°C	R. M. Value	Sap. Value	Iodine No.
1 *	638	6.85	43	28.4	230	29.4
**	665	.03	42.3	28	228	30.3
2 *	638	30	45.4	32.2	236	26.5
**	661	0.91	43	31.5	234	28.4
3 *	640	8.91	42.8	28.5	230	29.8
**	668	0.21	42.5	28.4	229	29.2
4 *	643	6.3	41.9	29	232	30.72
**	670	0.15	42	28.9	231	31.3
5 *	646	6.8	41.9	27.3	228	32.8
**	671	0.25	42	27.3	229	33.9
6 *	642	29.7	44	31	237.5	25.9
**	663	0.31	43.1	30.8	234	28.3

† TABLE No. 9

Original fresh sample

7	676	0.201	42.5	28.01	232	28.75
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Above sample was allowed to rancidify (butter)

*	646	16.41	43.5	30	235	26.3
**	670	0.22	42.7	30.01	232	28.60

Original sample of butter

8	673	0.56	42	28.93	231	32.5
*	647	9.8	42.5	30.01	234	31.18
**	669	0.12	42.3	29.91	232	31.8
*	640	20.6	43.0	31	235	30.06
**	671	0.13	42	29.04	232	31.94

Original sample of butter

9	678	0.48	42.5	29.7	230	31.4
*	644	7.56	43	30.4	232	30.9
**	674	0.01	42.7	29.91	231	31.2
*	638	16.75	43.5	30.8	233	29.98
**	675	0.2	42.8	30.1	231	30.92

* Sample of Buffalo ghee, with high acid value.

** Same sample after treatment.

† In this table fresh butter was allowed to rancidify and then that rancidified butter was again treated by dilute NaOH, washed and dried.

EFFECT OF AGEING OF GHEE ON MOLECULAR WEIGHT

In order to study the effect of ageing of ghee, samples of freshly prepared ghee were exposed to air only and periodically analysed. The results are given below :—

TABLE NO. 10

*Sample No. 1**Buffalo Ghee*

Period of Ageing	Mol. Wt.	Acid V.	B. R. at 40°C	R. M. Value	Sap. V.	Iodine No.
Starting day	674	0.89	42.5	28.5	228	30.1
After 1 month	674	1.1	42.5	28.5	229	29.5
„ 2 mths.	672	1.19	42.7	28.8	230	29.1
„ 3 „	671	1.5	42.8	28.9	231	28.62
„ 4 „	669	1.55	43.1	29.01	231	27.4

Sample No. 2

Starting day	670	1.2	41.6	31.4	231	29.3
After 1 month	670	1.4	41.3	31.4	231	28.7
„ 2 mths.	667	1.8	41.9	31.75	233	28.4
„ 3 „	664	2.02	42.2	31.9	234	27.9
„ 4 „	662	2.5	42.5	32.1	235	27.54

OXIDATION OF BUTTER-FAT

Oxygen was bubbled through freshly prepared Ghee at 100°C. and portions were taken out periodically at regular intervals and were analysed to observe the effect of oxidation on molecular weight.

TABLE NO. 11

*Sample No. 1**Buffalo Ghee*

Hours	Mol. Wt.	Acid V.	Iodine Value
0	676	1.847	30.2
6	676	1.800	29.91
12	680	1.975	29.57
18	688	2.38	28.72
24	672	2.9	27.2
30	662	3.82	26.64

*Sample No. 2**Ghee*

0	676	1.56	30.4
6	677	1.63	30.03
12	681	1.82	6.00
18	690	2.32	28.81
24	674	2.8	27.3
30	662	3.93	26.8

DISCUSSION

From a survey of the results so far obtained it can be seen that the molecular weights as calculated from the cryoscopic data are able to yield valuable information regarding the purity of oils and fats. It is possible to show that molecular weights of oils and fats are closely related to their saponification values. However, no accurate mathematical relationship can be indicated between them. Molecular weights are seen to be strongly influenced by the presence of free acids in the oils and fats; no such observations have been recorded in the case of saponification values.

In the study of the molecular weight of butter fat it is curious to note that molecular weights are constant for the same sample of ghee and the range of this value is very small in ghees of different places. The results indicate that the ranges of molecular weights of these samples will perhaps be of considerable use in determining the purity of ghee. It may be pointed out here that the samples of ghee were prepared out of butters by the usual Indian household method, i. e. heating butter-fat at 120° - 130° till almost all water contents are eliminated from the butter-fat.

The small range of molecular weights in different samples of ghees indicates that this method has a great promise towards the detection of adulteration of ghee by oils, fats and other substances.

The results from table Nos. 3, 4 and 5 support this observation. Artificial mixtures of different percentages of adulterants have been made and studied, and the study indicates the efficacy of the method.

It should be also noted that presence of free acids in different ghees, the origin of which is due to the acid-rancidity of the samples, lower the molecular weights of the ghees. By exposing fresh butter to air for different periods, it was possible to study the relation between acid value and lowering of molecular weights of the ghee produced from it. A graphical relation has been established with the help of such a study and a correction can now be applied for the influence of acid value on the molecular weights. From the results obtained the determination of molecular weights of oils and fats would offer interesting information regarding the purity of oils and fats.

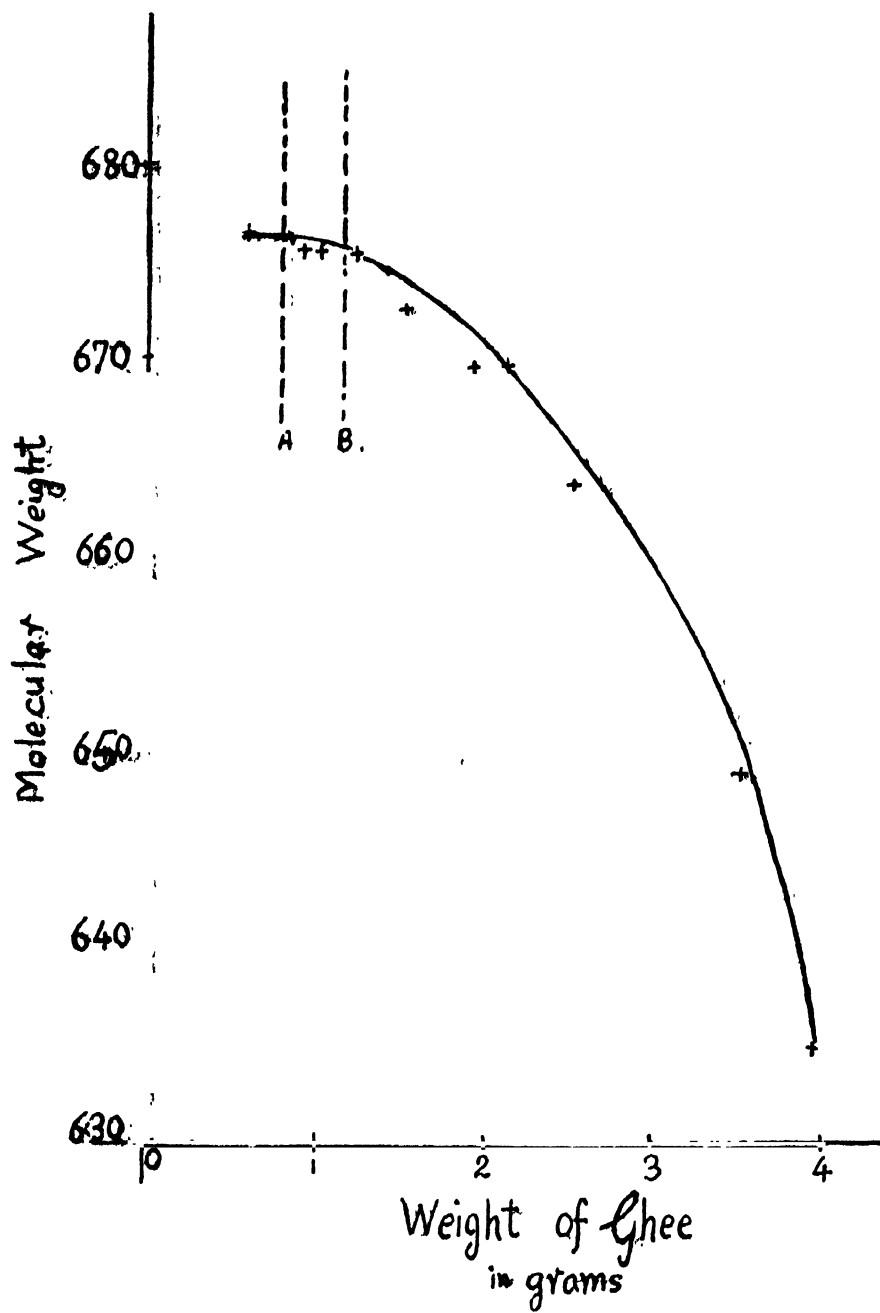
SUMMARY

(1) The average molecular weight of butter-fat does not vary to a great extent in spite of variation in the composition of the constituent fatty acids.

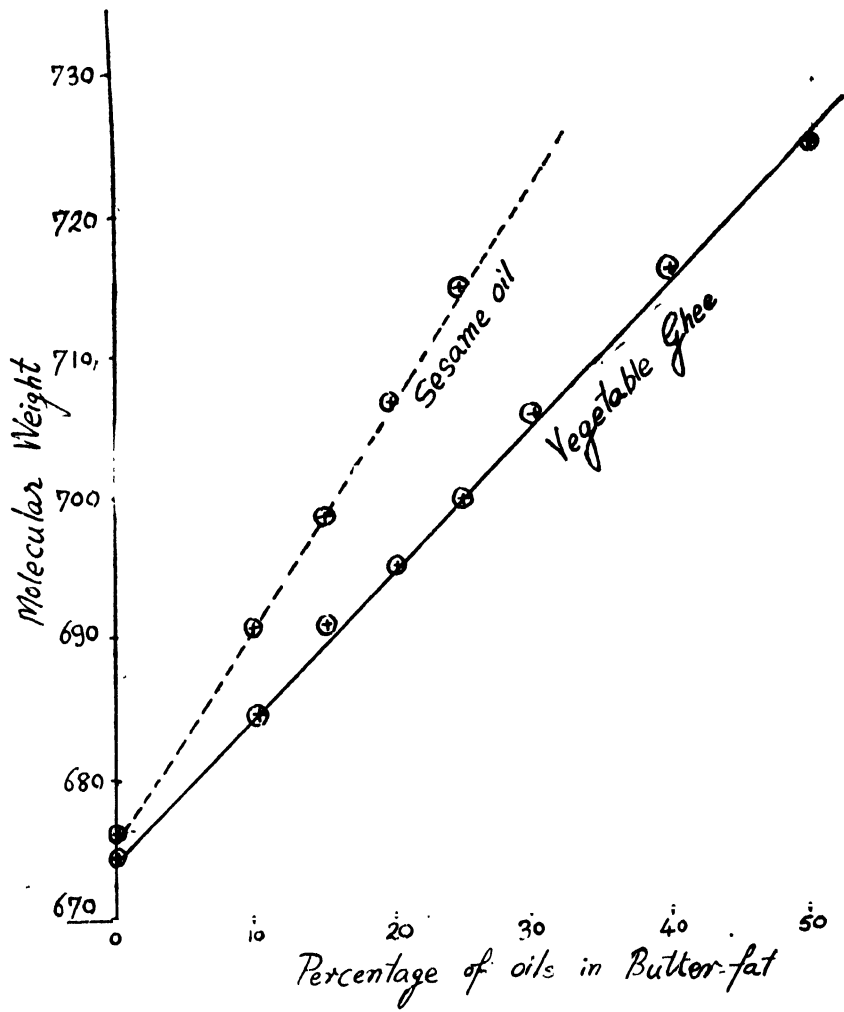
(2) The range of molecular weights of different samples of butter-fat is very narrow as compared with the range of different constants like Iodine value, Polenske value, R. M. value, etc. for the same samples of butter-fat.

(3) The average molecular weight of butter-fat differs distinctly from the average molecular weight of likely adulterants like Vanaspati, sesame oil, etc. Therefore adulteration of ghee to the extent of 7-10% can be easily detected by the cryoscopic method.

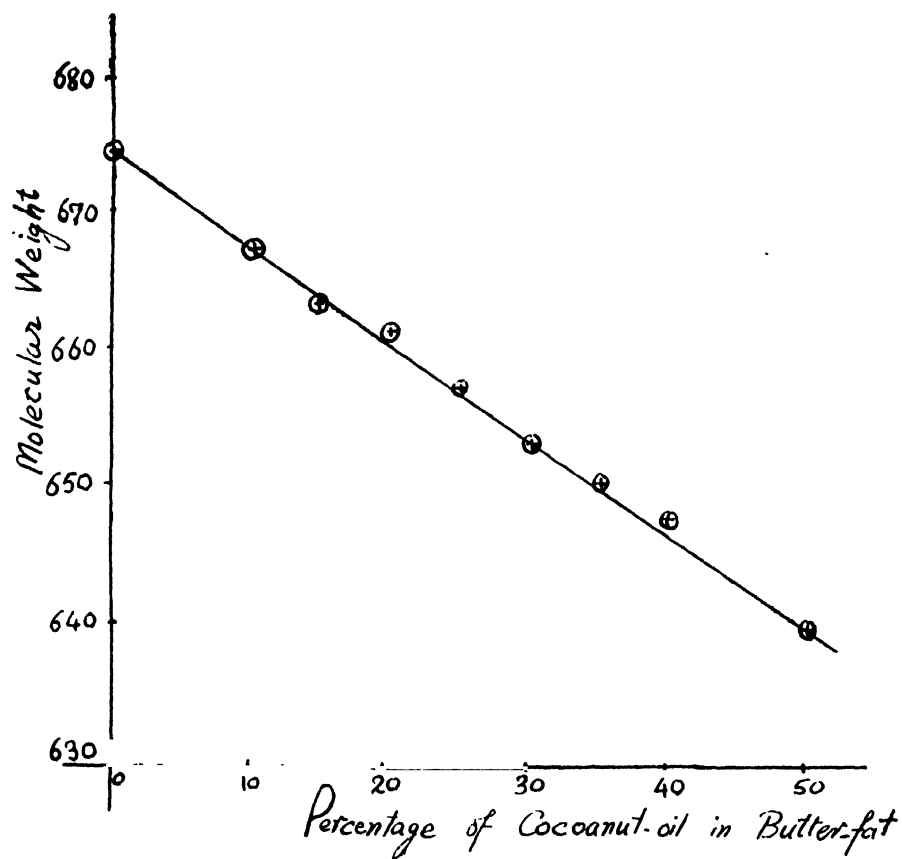
(4) In the case of butter-fat and cocoanut oil, the average molecular weight decreases with increase in the rancidity or the acid value.



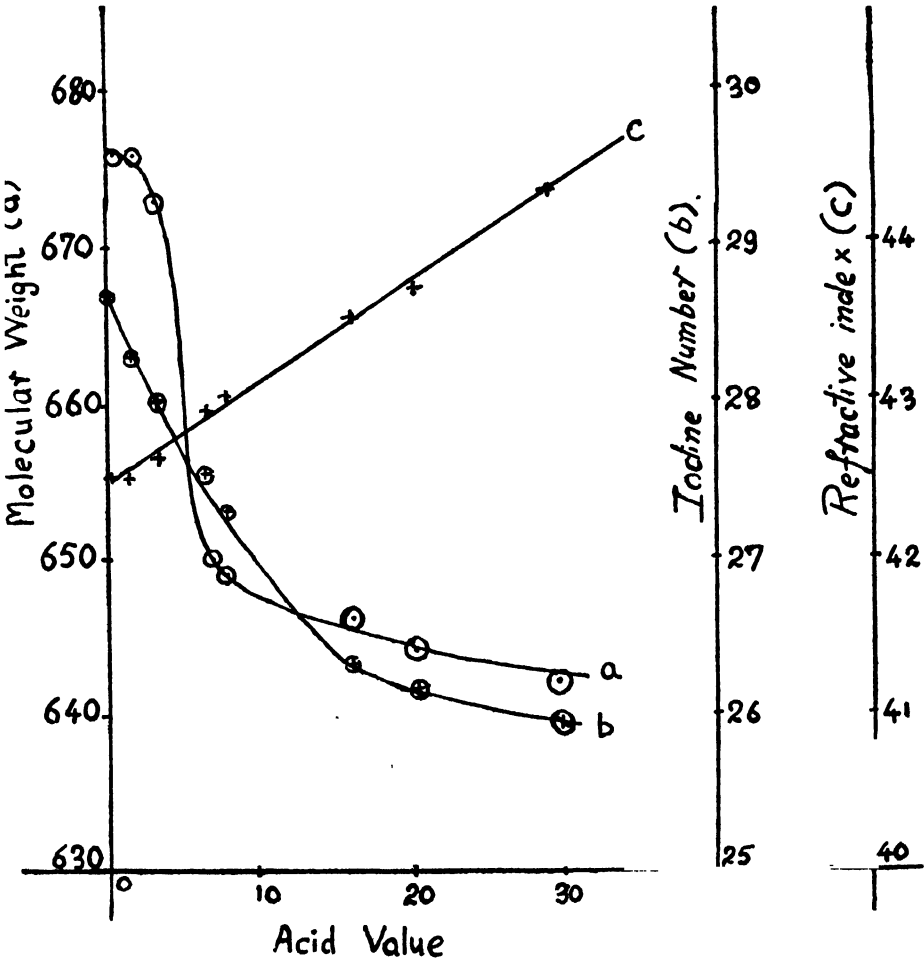
GRAPH No. 1



GRAPH No. 2



GRAPH No. 3



GRAPH No. 4

STUDIES IN THE SWELLING OF CELLULOSE, PART I

BY M. G. KARNIK AND S. C. DEODATTA

THE phenomenon of swelling of Cellulose has wide technical applications. The use of swelling agents like (1) Zinc-chloride (2) Calcium Thiocyanate (3) Sulphuric Acid (4) Phosphoric acid, etc., in finishing the textile materials, the production of parchment paper, vulcanised fibres, etc., is well known. Although various theories have been put forward from time to time to explain the swelling of Cellulose, little is known of the mechanism of the swelling process. A systematic study of the process of swelling of Cellulose in these reagents has been made recently by Dr. G. S. Kasbekar and S. M. Neale¹ at 25°C. In the commercial application of these reagents for the production of special finishes, etc., it is essential to obtain the maximum effect in the minimum of time. Evidently the study of the optimum conditions regarding the concentrations of the reagent and the temperature forms an important part of investigation in employing the aqueous solution of salts, acids and bases which cause swelling of Cellulose. The present investigation was undertaken with a view to note the effect of higher temperatures on the process of swelling. Accordingly the maximum percentage swelling and shrinkage of Cellulose and time required have been measured in the solutions of sulphuric acid and phosphoric acids of various concentrations at 40°C. Similar study at the temperatures of 50°C, 60°C and 75°C has been made and will be published in the subsequent parts.

The solutions of various concentrations of the two acids were prepared and the methods of Dr. G. S. Kasbekar and S. M. Neale¹ were employed to determine their exact strengths, and for the measurement of swelling of Cellophane and shrinkage of twofold yarn of 28s count of Sakillaridis cotton previously bleached.

The following observations are made :—

The swelling and shrinkage in solutions of sulphuric acid :—

- (1) The percentage swelling increases with the increase in concentration upto a concentration of 61.50 per cent and then decreases.
- (2) Cellulose disintegrates immediately in solutions stronger than 69.80 per cent.
- (3) The time required to attain the maximum swelling decreases with the increase in concentration.

- (4) Cellulose swells more than at 25°C upto a concentration of 63.86%.
- (5) The percentage shrinkage increases with the increase in concentration upto a concentration of 63.86% and then decreases.
- (6) The time required for the maximum shrinkage decreases with the increase in concentration.
- (7) The per cent shrinkage is more than at 25°C for concentrations upto 63.86 per cent and becomes less as the concentration increases. The highest percent shrinkage of 57.18% is attained in the concentration of 63.86% while in concentration of 69.80% per cent and beyond the yarn breaks immediately at 40°C.
- (8) The time required to attain the maximum shrinkage is more than at 25°C upto a concentration of 39.72% and less at higher concentrations.

Swelling and shrinkage in solutions of phosphoric acid

1. Both the swelling and shrinkage increase with the concentration upto a concentration of 82.80% and then decrease. The highest swelling of 4000% and shrinkage of 55.4% are attained in the concentration of 82.80%.

2. The time required to attain the maximum swelling of Cellulose as well as shrinkage of yarn decreases with the increase in concentration.

3. The Cellulose swells more than at 25°C in all the concentrations.

REFERENCE

- (1) G. S. Kasbekar and S. M. Neale, 'Trans. Far. Soc. Aug.-Sept. 1947, p. 517.

TABLE NO. 1

Swelling of Cellulose in Solutions of Sulphuric Acid of Various Concentration at 40°C.

Concentration % by Weight	Weight of Dry Cellulose in gm.	Weight of Solution absorbed gm.	Swelling per cent	Weight of solution absorbed per 162 gms of Cellulose in gm.	Time of Swelling in minutes	Per 162 gms. of Cellulose	
						Gm. mols of the acid	Gm. mols of water
21.02	0.1214	0.1396	115.0	186.3	60	0.5230	7.499
39.72	0.3406	0.6134	180.1	291.7	40	1.107	10.18
50.60	0.2010	0.4523	225.0	364.5	30	1.724	10.86
59.10	0.1648	1.2203	740.5	1200	20	8.000	23.05
60.98	0.1870	2.8106	1503	2435	15	18.16	36.39
61.50	0.2000	4.800	2400	3888	15	24.72	81.39
63.86	0.1608	3.5376	2200	3563	15	22.05	77.87
66.60	0.3005	5.4631	1818	2944	5	18.12	64.89
69.80	0.1100	1.8392	1672	2708	4	16.50	60.60
71.90	Disintegrated.						

TABLE NO. 2

Shrinkage of Cellulose in Solutions of Sulphuric Acid at 40°C.

Concentration % by Weight	Maximum % Shrinkage	Time for Maximum Shrinkage—Minutes
21·02	0·804	10·0
39·72	1·50	7·0
50·60	2·10	5·0
59·10	5·45	4·0
60·98	10·00	3·75
61·50	22·00	2·5
63·88	57·18	0·75
66·60	25·00	0·25
69·80	breaks	

TABLE NO. 3

Swelling of Cellulose in Solutions of Phosphoric Acid of Various Concentrations at 40°C.

Concentration % by Weight	Weight of Dry Cellulose in gms.	Weight of Solution absorbed gms.	Swelling %	Weight of Solution ab- sorbed per 162 gms. of Cellulose in gms.	Time of Swelling in Hours	Per 162 gms. of Cellulose	
						Gm. mols of the Acid	Gm. mols of Water
52·00	0·1678	0·3524	210·0	340·2	2·0	2·031	7·844
57·01	0·1426	0·3524	247·1	400·3	1·5	2·086	10·99
70·80	0·2004	1·0022	500·1	810·0	1·0	5·124	17·11
80·01	0·1670	5·0768	3040	4925	0·5	40·12	55·16
82·80	0·2108	8·4383	4003	6485	0·5000	50·34	85·94
87·50	0·1840	5·0011	2718	4403	0·4167	38·67	34·06
89·60	0·2016	4·8424	2402	3891	0·3333	34·07	30·67

TABLE NO. 4

Shrinkage of Cellulose in Solutions of Phosphoric Acid at 40°C.

Concentration % by Weight	Maximum % Shrinkage	Time for Maximum Shrinkage—Minutes
52·00	1·02	30·0
57·00	2·00	25·0
70·80	3·90	20·0
77·10	8·00	20·0
80·01	15·00	20·0
82·80	55·40	10·0
87·50	25·20	10·0
89·60	21·16	6·0

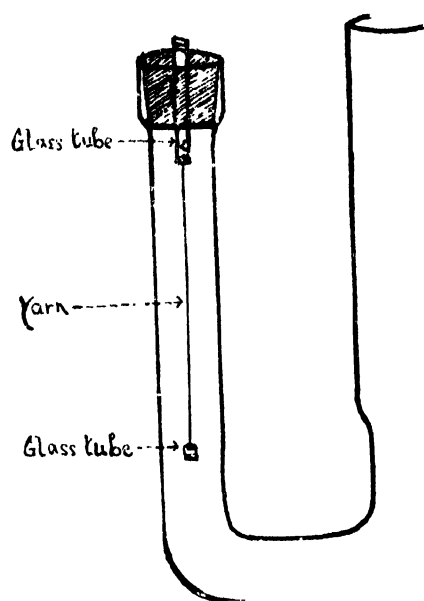


Fig. 1.

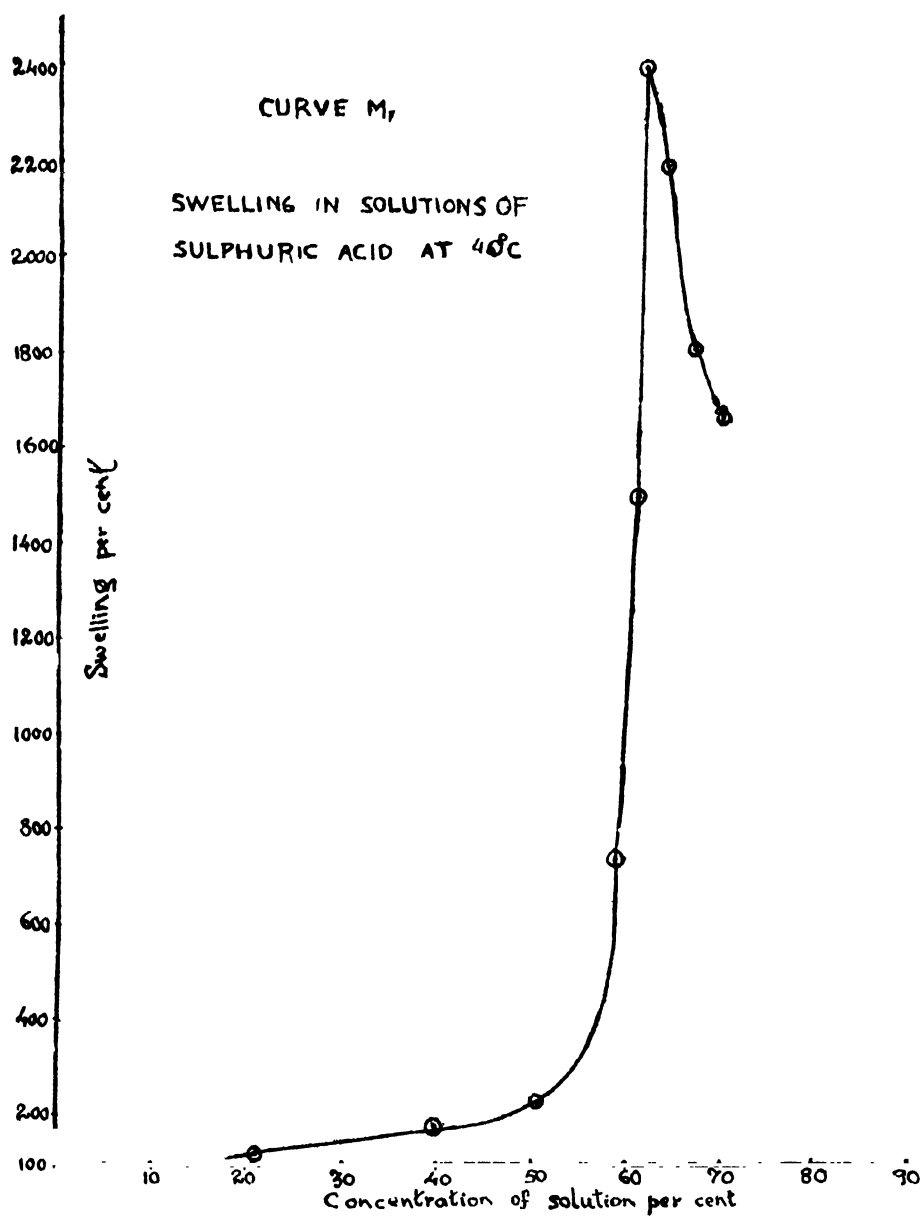


FIG. 2

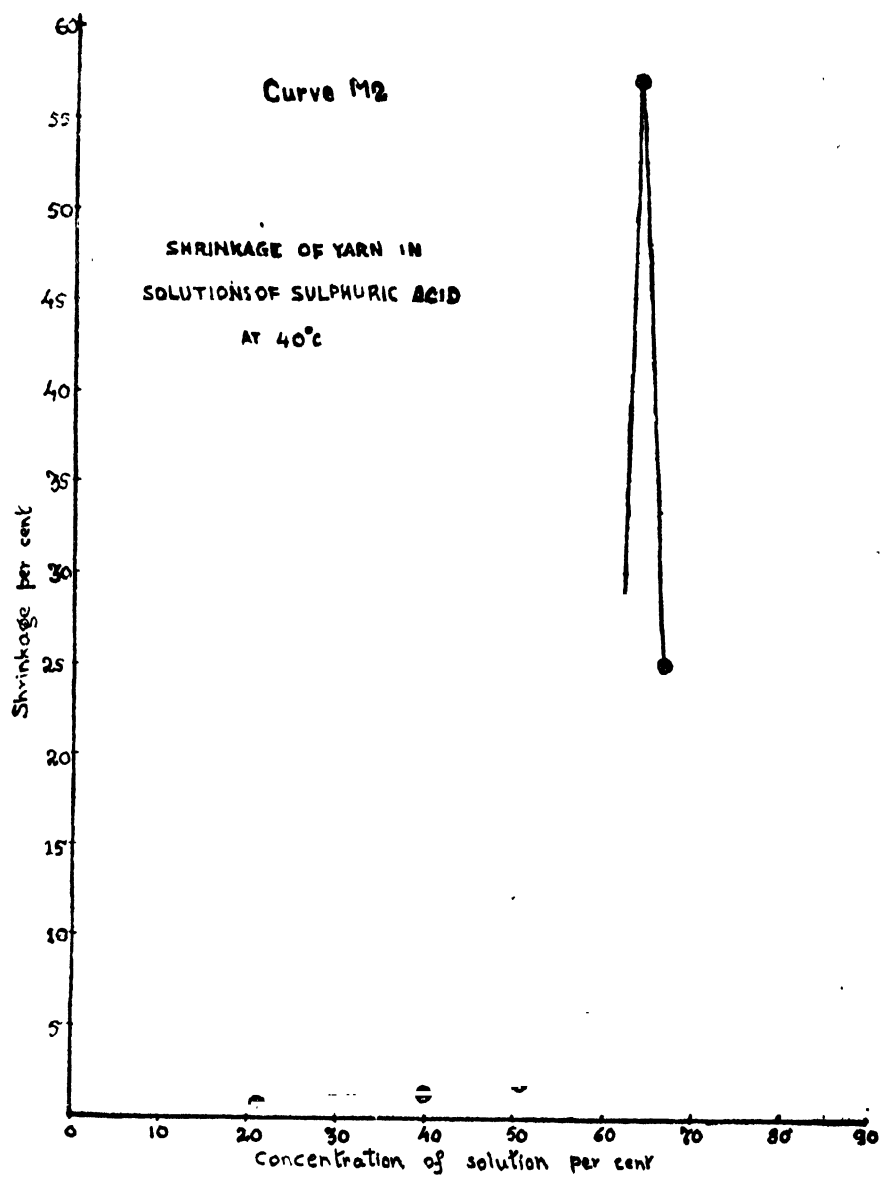


FIG. 3

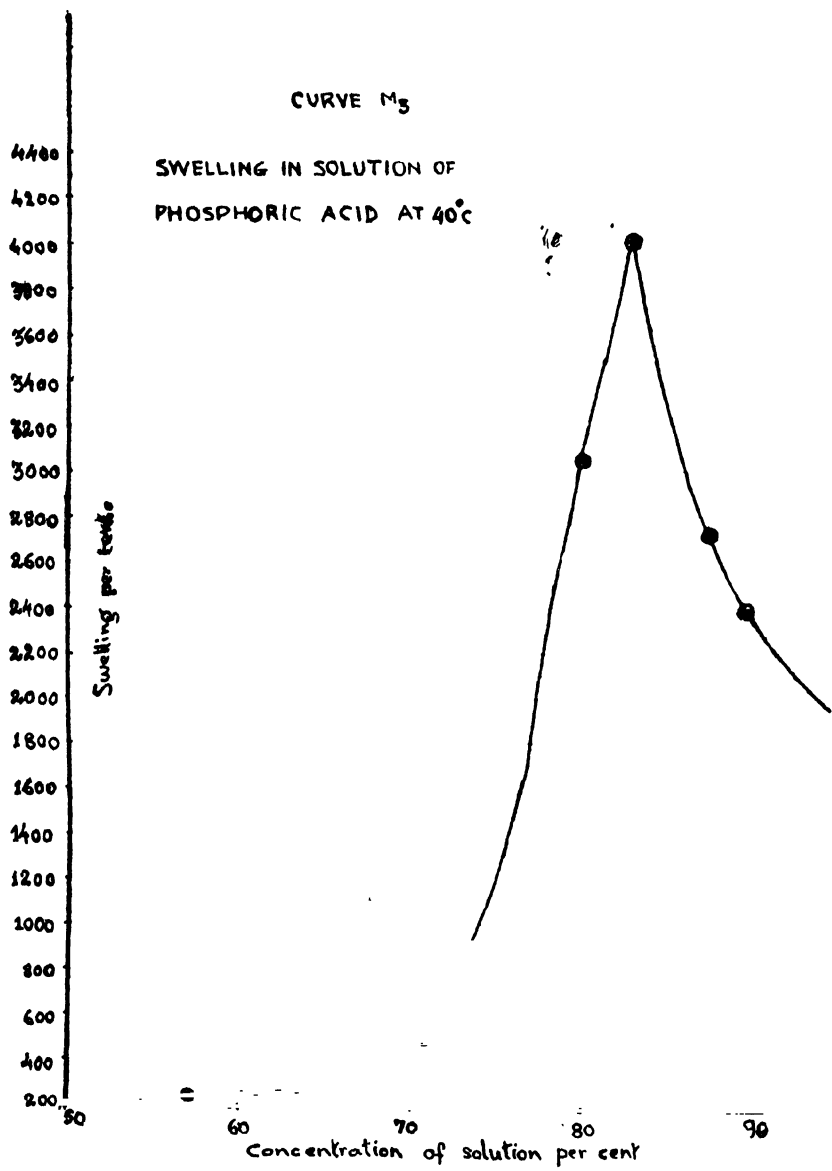


FIG. 4

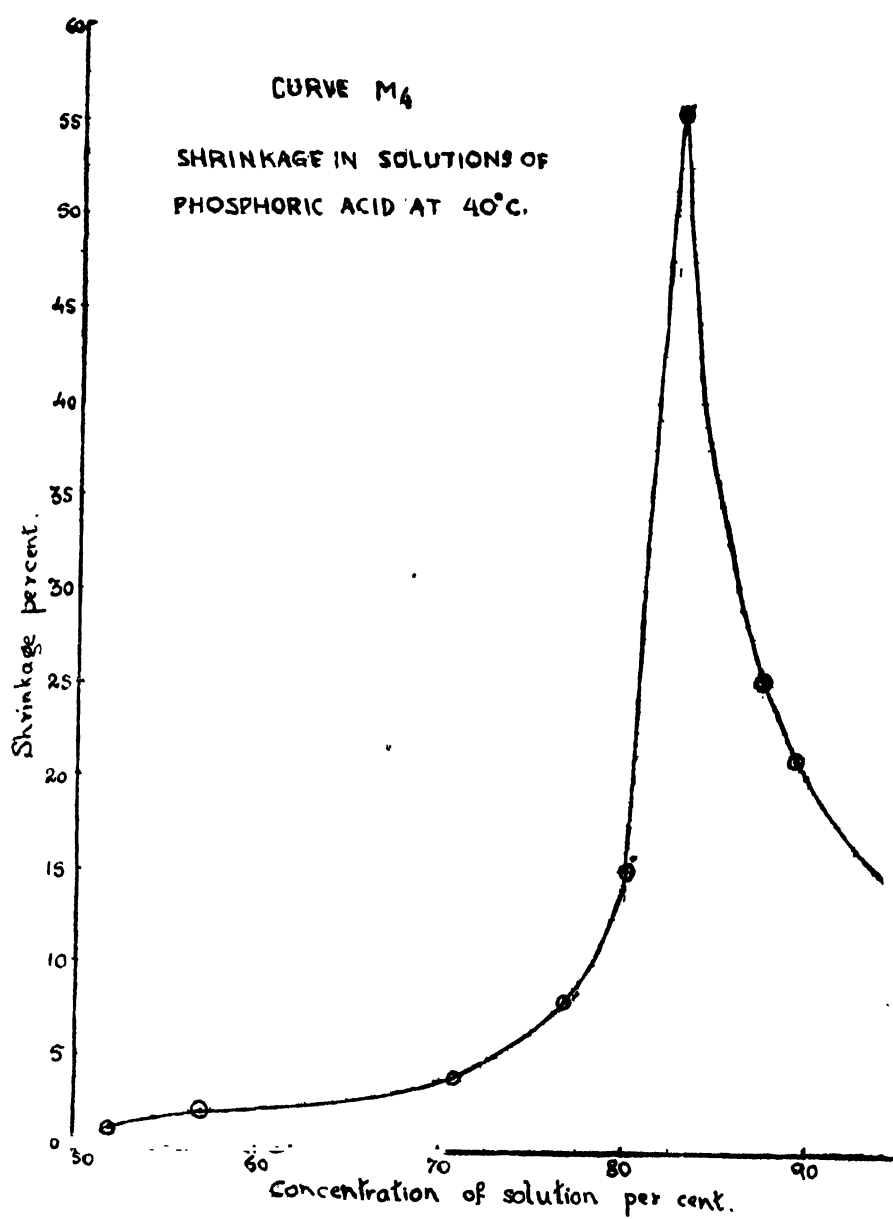


FIG. 5

RELATIVE OPTICAL AND HEAT ABSORPTION BY CERTAIN INORGANIC SALT IN AQUEOUS SOLUTION

BY PRAMOD LAI SARMA

[The relative optical and heat absorptions by aqueous potash alum, potassium chloride, ferrous ammonium sulphate, nickel sulphate and copper sulphate were determined. The last appeared to be best adapted as filters for the heat and nickel sulphate for light].

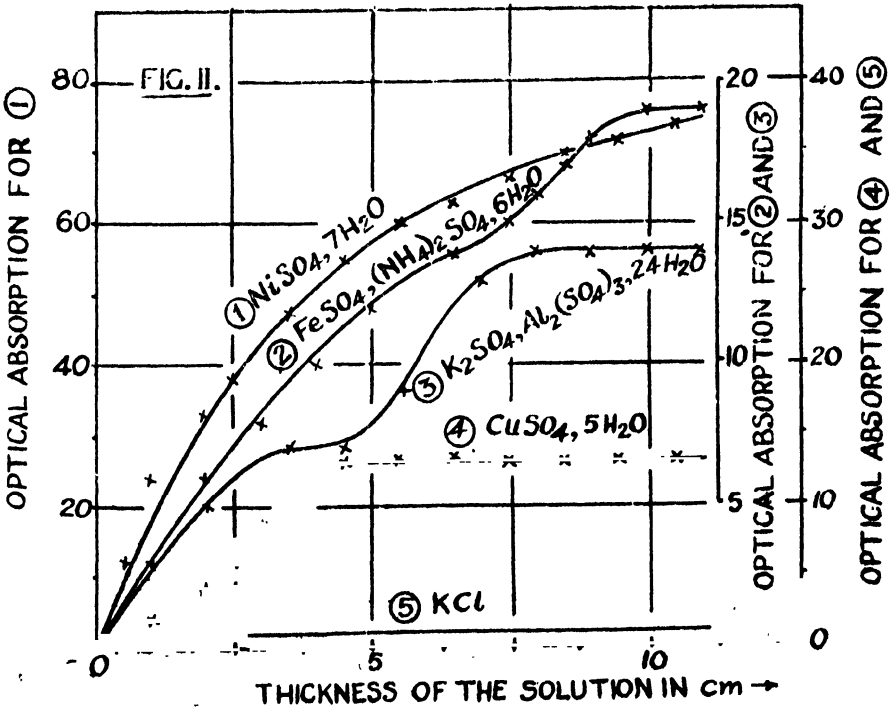
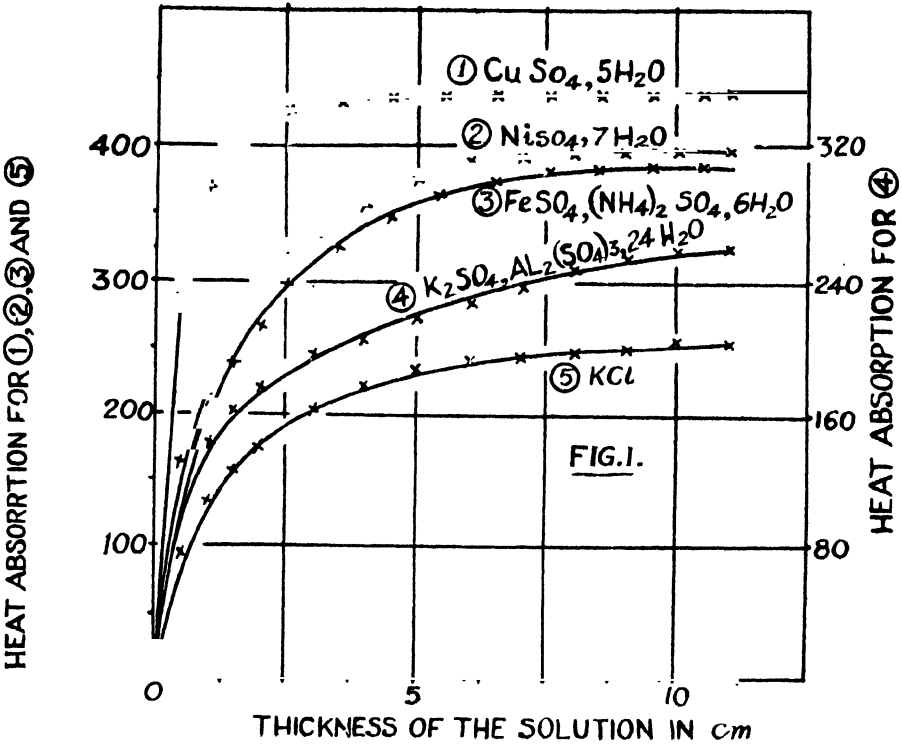
ARISING out of studies in different parts of the spectrum of the Joshi-Efect, viz., an instantaneous current decrease on irradiation (Presi. Add. Chem. Sec., Ind. Sci. Cong., 1943), the following work was carried out in order to determine the relative optical and heat absorptions by certain inorganic salts in aqueous solutions (*vide infra*).

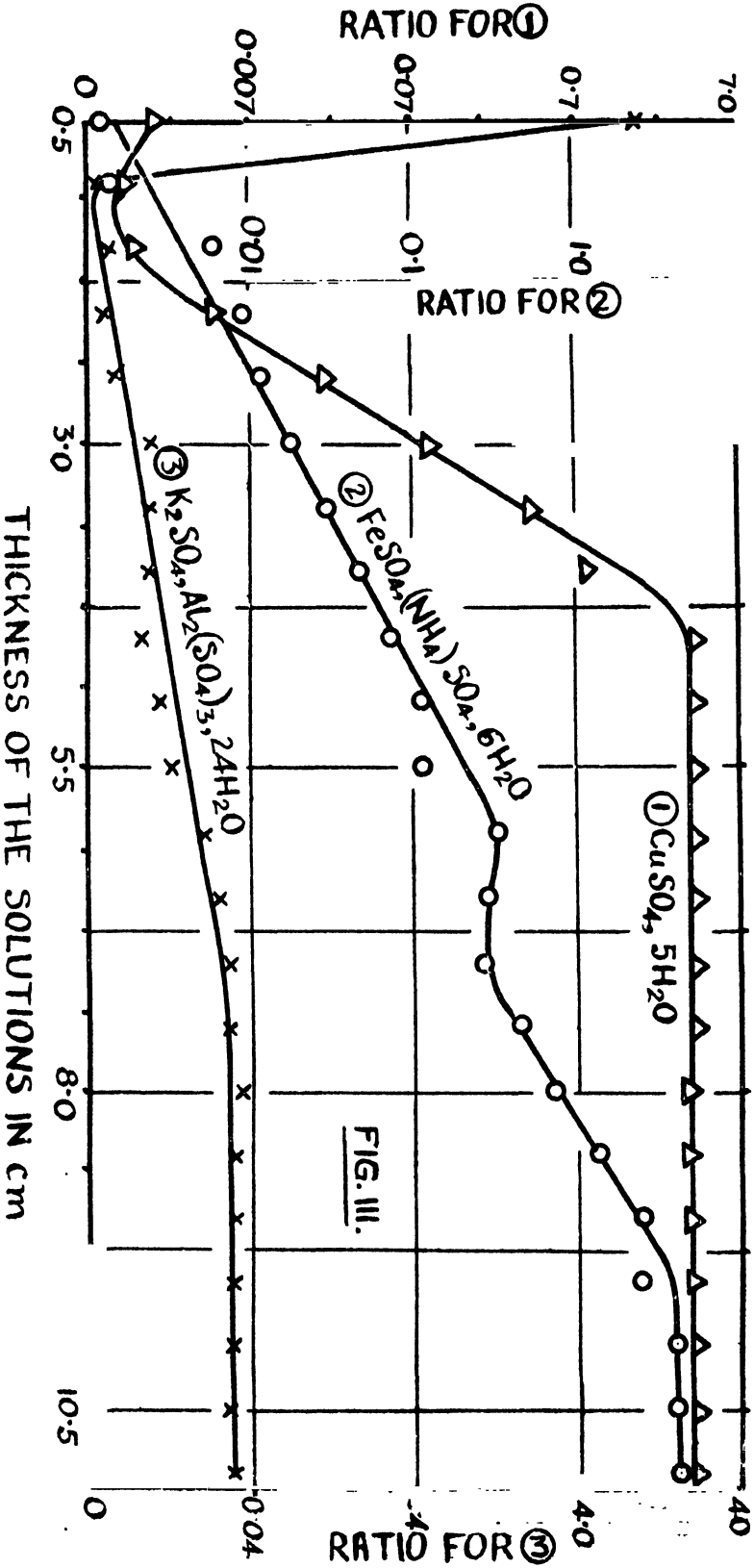
EXPERIMENTAL

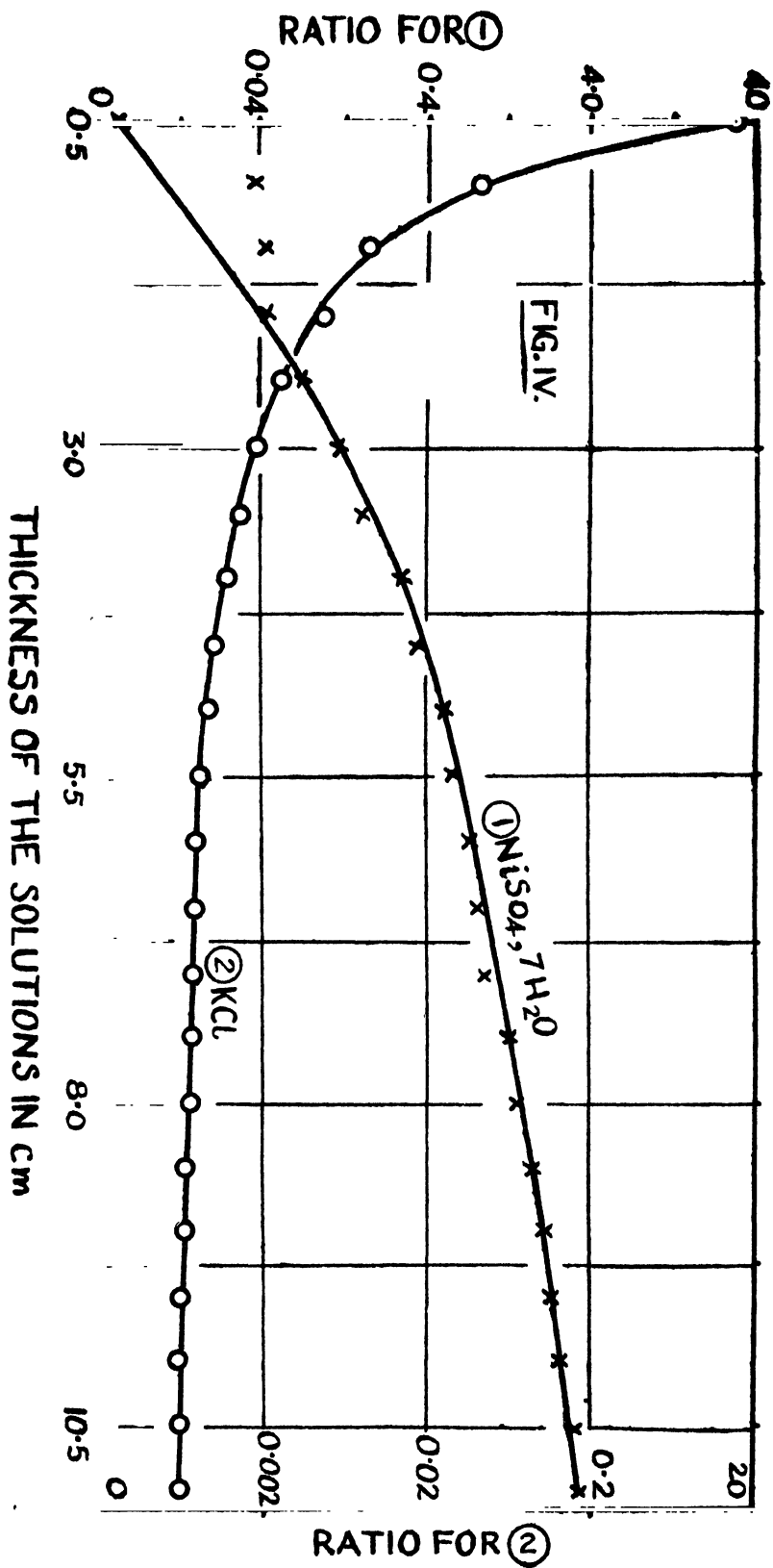
M/10 solution of copper-, nickel-, ferrous ammonium sulphate (acidified) and potassium chloride ; and M/15 solution of potash alum were used. The experimental arrangement consisted essentially of a 180-volt incandescent bulb (glass) as a source of both heat and light. The collimated radiation passed successively through a circular diaphragm ; a definite amount of the solution in a beaker whose absorption was to be observed ; and a second diaphragm. It was finally allowed to fall either on a thermopile (Kipps 37) or a potassium coated photo-electric cell. The former measured the heat absorption and the latter optical absorption.

Progressively increasing amounts of the solution were pipetted into the beaker so as to increase the thickness of the absorbing column by steps of half a centimeter, and the galvanometer reading was recorded. The absorption by a given thickness of solution was obtained by subtracting the corresponding galvanometer reading from the initial reading when the container was empty.

The absorption in the visible by the copper-, nickel- and ferrous ammonium sulphate solutions was determined from their absorption spectra. No absorption was observed in all the solutions examined within the range 4000Å to 6680Å. The intensities at two corresponding points in the two halves of a twin spectrum were determined by a microphotometer. Any unidentical condition in the exposure of the two halves of the twin spectra was indicated by the non-superimposition of the curves of the 'control' i.e., a twin spectrum of water, whose two halves had the same thickness and time of exposure. Corrections were introduced to each pair of curves in such cases.







DISCUSSION

In agreement with the results of Smith (*Phys. Rev.* 1933, *44*, 520-523) on light absorption by aqueous potassium chloride in the far ultra violet (which lies beyond the photo-sensitivity range, 3500A to 5700A, of an alkali photoelectric cell), potassium chloride solution showed but negligible absorption (Fig. II) ; that of other solutions was comparable in respect of heat and light (Figs. I and II).

The foregoing curves show that the increase of heat absorption with the thickness of the absorbing column is markedly rapid at small values of the latter ; it attains finally a sensibly constant value (Fig. I) ; the results for optical absorption (Fig. II) are essentially similar. It would appear that comparatively the optical absorption continues over a greater range of absorbing thickness, except in the case of potassium chloride solution (Fig. II). These results also show that copper sulphate and nickel sulphate are well adapted as the heat and light filter respectively.

It is instructive to find that the ratio of optical to heat absorption varies with the thickness and reaches a constant value ultimately (Figs. III and IV). Before the attainment of this constant value, the ratio shows an increase in the case of nickel- and ferrous ammonium sulphate, and decreases in potassium chloride. In copper sulphate and potash alum solutions, however, there is an initial decrease followed by an increase to a constant maximum.

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7-HYDROXY-6-ACYL-COUMARINS CONTAINING LONG-CHAIN ACYL GROUPS

By H. P. KANSARA AND N. M. SHAH

CHUDGAR AND SHAH (J. Univ. Bom., 1942, 11, (iii) 113; J. I. C. S., 1944, 21, 175) have obtained 5-hydroxy-6-acyl-4-methyl coumarins by the condensation of 4-acyl-resorcinols with acetoacetic ester in presence of anhydrous aluminium chloride. The isomeric 7-hydroxy-coumarins have not yet been investigated and their synthesis forms the subject-matter of the present work.

Three methods for their syntheses are possible : (i) the Pechmann condensation of 4-acyl resorcinols in presence of a suitable condensing agent, (ii) the Fries migration of the acyloxy derivatives of 7-hydroxy-coumarin, and (iii) the Friedel-Crafts acylation of 7-hydroxy-coumarin derivatives.

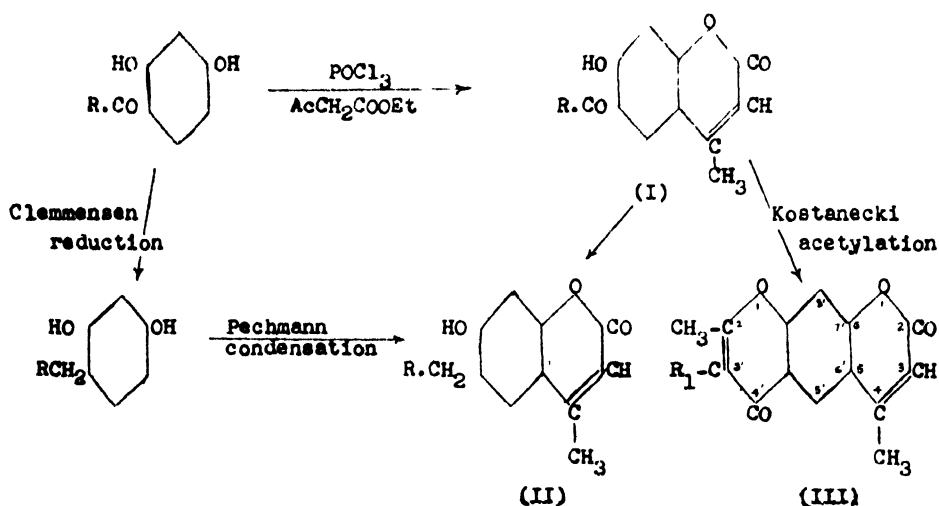
The Fries migration of 7-acyloxy-coumarins predominantly yields 7-hydroxy-8-acyl-coumarin derivatives (Limaye, Ber., 1932, 65, 375; Rasayanam, 1936, 1, 35; Thakor and Shah, J. I. C. S., 1946, 23, 199); while the Friedel-Crafts acylation does not succeed (Desai and Hamid, Proc. Ind. Acad. Sc., 1937, 6A, 185). Hence the first method is the one left out for trial.

The condensation of 4-acyl resorcinols with ethyl acetoacetate does not succeed under the customary conditions of the Pechmann reaction. After several attempts, it was observed that the condensation could be successfully affected in dry benzene as solvent, using phosphorus oxychloride as the condensing agent (Desai and Hamid, *loc. cit.*). The 4-acyl resorcinols containing long chain acyl groups, viz., 4-stearyl-, 4-palmityl-, and 4-lauryl-resorcinols were thus successfully condensed with acetoacetic ester with the production of the coumarin derivatives. The constitution, 7-hydroxy-6-acyl-4-methyl coumarin (I) has been assigned, to the product on the following grounds :

- (i) the product gives positive colour test with alcoholic ferric chloride indicating -OH and -COR in ortho position. It dissolves in alkali with non-fluorescent yellow colour. It gives acetyl derivative, oxime and semicarbazone proving the presence of -OH and -COR groups.
- (ii) by analogy with other ketone condensations with acetoacetic ester in presence of phosphorous oxychloride, that a 7-hydroxy-6-acyl coumarin derivative is formed (Desai and Hamid, *loc. cit.*).

(iii) the condensation product on Clemmensen reduction gives 7-hydroxy-6-alkyl-4-methyl coumarin (II) which exhibits blue fluorescence in alkali solution, characteristic of a 7-hydroxy coumarin derivative. The reduction product (II) on direct comparison with 7-hydroxy-6-alkyl-4-methyl coumarin obtained by the Pechmann condensation of 4-alkyl resorcinols (Chudgar and Shah, J. Univ. Bom., 1944, 13 (iii), 18) was found to be identical in all respects.

(iv) on Kostanecki acetylation, it gives the chromono-pyrones (III).



EXPERIMENTAL

Condensation of 4-stearyl-resorcinol with ethyl acetoacetate: Formation of 7-hydroxy-6-stearyl-4-methyl coumarin (I: R=C₁₇H₃₅)

4-stearyl-resorcinol required for this work was prepared by Nencki reaction (Desai and Waravdekar, Proc. Ind. Acad. Sc., 1941, 13 A, 177).

Dry powdered 4-stearyl-resorcinol (7 g.), acetoacetic ester (3 g.) anhydrous benzene (40 c. c.) and phosphorus oxychloride (2 c. c.) were refluxed in a flask fitted with a CaCl₂ guard tube on a water bath for six hours: hydrochloric fumes were evolved as the reaction proceeded. The reaction mixture was shaken occasionally. After the evolution of the gas had slackened, the contents of the flask were transferred into a dry beaker and left overnight. As benzene evaporated off, a yellowish brown solid began to separate. It was collected and crystallised from alcohol, pale yellow needles, m. p. 101°. Yield=3.5 gms. (Found: C, 76.6; H, 8.76. C₂₈H₄₂O₄ requires C, 76.0; H, 9.5 per cent). The coumarin is soluble in alcohol and benzene. It dissolves in alcoholic alkali with non-fluorescent yellow colour, and gives wine-red colour with alcoholic ferric chloride.

The acetyl derivative prepared by acetic anhydride-pyridine method by heating on water bath for 4 hours crystallised from acetic acid, needles m. p. 74°. (Found: C, 74.9; H, 9.5; C₃₀H₄₄O₅ requires C, 74.4; H, 9.1 per cent).

The *oxime* prepared as usual melted at 220-21° (decomp).

The semicarbazone melted at 202° (decomp).

Clemmensen reduction: formation of 7-hydroxy-6-octadecyl-4-methylcoumarin (II: $R=C_{17}H_{35}$).

Zinc amalgam was prepared according to the modified method of Robinson and Shah (J., 1934, 1497).

The condensation product (1 g.) dissolved in alcohol was added to zinc amalgam (20 g.). Dilute hydrochloric acid (1 : 1; 25 c.c.) was added and the mixture heated on sand bath for 4 hours. As the reduction proceeded, the product went into solution. Heating was continued till a drop of the reaction mixture gave no colour with alcoholic ferric chloride. The solution was then filtered hot from unchanged amalgam. The filtrate on cooling deposited a solid which was collected and crystallised from alcohol, clusters of small needles, m. p. 115-116° (Found : C, 78.7; H, 10.5. $C_{28}H_{44}O_3$ requires C, 78.5; H, 10.3 per cent). The product gives intense blue fluorescence in alkaline solution and no colour with alcoholic ferric chloride.

The reduction product on direct comparison with 7-hydroxy-6-octadecyl-4-methyl coumarin (Chudgar and Shah, J. Univ. Bom., 1942, 11, (iii), 113) was found to be identical with it in all respects.

Kostanecki Acetylation: formation of 2': 4-dimethyl-3'-hexadecyl-chromono-6': 7': 5 : 6- α -pyrone (III: $R_1=C_{16}H_{33}$).

The condensation product (1 g.) was mixed with acetic anhydride (10 c. c.) and fused sodium acetate (1.5 g.) and the mixture refluxed on oil bath at 140-150° for 12 hours. The cooled reaction mixture was treated with water: a soft solid separated. It was collected, washed with water and crystallised from alcohol, needles, m. p. 123-24° (Found : C, 77.0; H, 9.24. $C_{30}H_{42}O_4$ requires C, 77.6; H, 9.44 per cent).

4-palmityl—and-4-lauryl resorcinols were similarly condensed and the respective coumarins obtained. For their preparation as well as of their various derivatives, we have adhered to the details followed in the case of 4-stearyl-resorcinol. Therefore, only the necessary information regarding their properties has been given omitting all the preparative details to avoid repetitions. The ketones required for this work were also prepared according to Desai and Waravdekar (*loc. cit.*).

7-hydroxy-6-palmityl-4-methyl coumarin (I: $R=C_{15}H_{31}$) was obtained from 4-palmityl resorcinol as before, m. p. 107° (Found : C, 75.8; H, 9.1. $C_{26}H_{38}O_4$ requires C, 75.4; H, 9.2 per cent).

The *acetyl* derivative prepared as before crystallised from acetic acid, needles, m. p. 105° (Found : C, 73.81; H, 8.6. $C_{28}H_{40}O_5$ requires C, 73.6; H, 8.8 percent).

The *oxime* was obtained as needles, m. p. 218° (decomp.).

The semicarbazone melted at 253° (decomp.).

Clemmensen Reduction : The keto coumarin was reduced as in the previous case. 7-hydroxy-6-hexadecyl-4-methyl coumarin (II : $R = C_{15}H_{31}$) was found identical with an authentic sample (Chudgar and Shah, J. Univ. Bom., 1944, 13 (iii), 20) on direct comparison: m. p. and mixed m. p. 127° (Found : C, 77.75 ; H, 10.1. $C_{26}H_{40}O_3$ requires C, 78.0 ; H, 10.0 per cent).

2' : 4-dimethyl-3'-tetradecyl chromono-6' : 7' : 5 : 6- α -pyrone (III : $R_1 = -C_{14}H_{29}$) was obtained as before m. p. 129° (Found C, 77.2 ; H, 9.0. $C_{28}H_{38}O_4$ requires C, 76.7 ; H, 8.7 per cent).

7-hydroxy-6-lauryl-4-methyl coumarin (I : $R = -C_{11}H_{23}$) was prepared from 4-lauryl resorcinol as before, needles, m. p. 115° (Found : C, 74.0 ; H, 8.6. $C_{22}H_{30}O_4$ requires C, 73.7 ; H, 8.4 per cent).

The acetyl derivative crystallised from acetic acid, small plates m. p. 121° (Found : C, 72.35 ; H, 8.4. $C_{24}H_{32}O_5$ requires C, 72.0 ; H, 8.0 per cent).

The semicarbazone melted at 256° (decomp.)

7-hydroxy-6-dodecyl-4-methyl coumarin (II : $R = -C_{11}H_{23}$) obtained by the Clemmensen reduction of the keto-coumarin crystallised from alcohol, needles, m. p. 133° (Found : C, 76.8 ; H, 9.2. $C_{22}H_{32}O_3$ requires C, 76.7 ; H, 9.3 per cent).

The same coumarin was also obtained by the Pechmann condensation of 4-dodecyl resorcinol (Chudgar and Shah, *loc. cit.*) and was found identical with the above reduction product.

2' : 4-dimethyl-3'-decyl-chromono-6' : 7' : 5 : 6- α -pyrone (III : $R = -C_{10}H_{21}$) crystallised from alcohol m. p. $137-138^{\circ}$ (Found : C, 75.0 ; H, 8.0. $C_{24}H_{30}O_4$ requires C, 75.4 ; H, 7.8 per cent).

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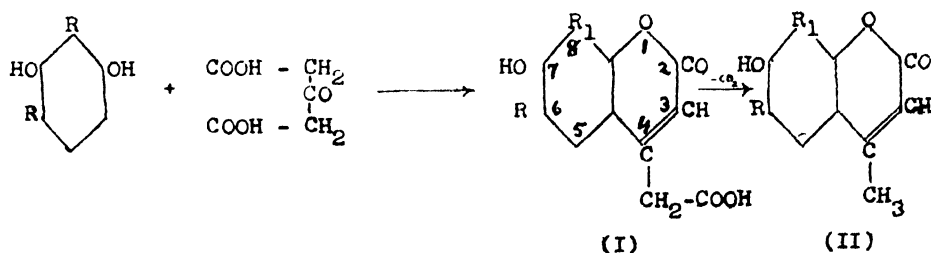
COUMARIN-4-ACETIC ACIDS DERIVED FROM VARIOUS SUBSTITUTED PHENOLS

BY H. P. KANSARA AND N. M. SHAH

DEY (J., 1915, 1606) carried out a systematic and detailed study of the condensation of acetone dicarboxylic acid and its ester with several phenols. He obtained coumarin-4-acetic acids in varying yields, depending upon the nature of the phenol. Dey, however, was unsuccessful in obtaining coumarin-4-acetic acid, which was later on synthesised by Limaye (J. I. C. S., 1927, 4, 159). Recently Sethna and Shah (J. I. C. S., 1940, 17, 37) while studying the influence of 4-carbomethoxy group in resorcinol nucleus on the Pechmann reaction condensed methyl β -resorcyate with acetone dicarboxylic ester and obtained ethyl 7-hydroxy-6-carbomethoxy-coumarin-4-acetate. It thus appears that practically little work has been done on the Pechmann condensation of substituted phenols with acetone dicarboxylic acid or its ester. The work described in this paper relates to the condensation of acetone dicarboxylic acid with various substituted phenols which have not been investigated so far, viz., 4-ethyl-, 4-propyl-, 4-chloro-, 4-bromo-, 4-acetyl- and 2-acetyl-resorcinols, methyl β resorcyate as well as 4-ethyl-pyrogallol, 4-acetyl-pyrogallol and pyrogallol-4-carboxylic ester.

The preliminary work was done by condensing 4-ethyl-resorcinol with acetone dicarboxylic acid in presence of sulphuric acid. But as the acid was not easily available, Dey and Rows' (J. I. C. S., 1924, 1, 112) modification of using citric-sulphuric acid mixture as an incipient source of acetone dicarboxylic acid has been successfully utilised throughout this work.

All the condensations were carried out at the temperature of ice bath. It was found that the substituted resorcinols could be smoothly condensed and good yields of the condensation product (I: R = Et, Pr, Br, Cl -COOMe: R₁ = H) obtained, except in case of 4-acetyl resorcinol. Similarly, 2-acetyl-resorcinol also underwent the condensation giving the corresponding coumarin-4-acetic acid (I: R₁ = COCH₃: R = H). The reaction was extended to the substituted pyrogallol derivatives: they also underwent the condensation smoothly yielding 7:8-dihydroxy-coumarin-4-acetic acid derivatives (I: R₁ = OH: R = Et, -COOMe.) But, 4-acetyl pyrogallol did not condense.



The constitution (I) has been assigned to the condensation product, as (a) it is soluble in sodium bicarbonate solution with effervescence and (b) is easily de-carboxylated on heating above its melting point yielding the corresponding 4-methyl-coumarin derivative (II)—a reaction characteristic of coumarin 4-acetic acids.

Further, the 7-hydroxy-coumarin-4-acetic acid derivatives obtained from 4-substituted resorcinols exhibit blue fluorescence in alkaline solution, characteristic of umbelliferrone derivatives: the acid derived from 2-acetyl-resorcinol dissolves with yellow non-fluorescent colour. The coumarin-4-acetic acids derived from the pyrogallol derivatives give deep orange solutions in alkali and sulphuric acid.

The non-condensation of 4-acetyl-resorcinol and -pyrogallol is in agreement with the previous similar observations as resacetophenone and other 4-acyl resorcinols do not condense with β -ketonic esters under the customary conditions of Pechmann reaction (Shah and Shah, J., 1939, 1250).

Sethna and Shah (*loc. cit.*) on hydrolysis of their ethyl 7-hydroxy-6-carbomethoxy-coumarin-4-acetate obtained mainly 7-hydroxy-4-methyl coumarin-6-carboxylic acid instead of the expected coumarin-4-acetic acid (I: $R = -COOMe$; $R_1 = H$) which has been directly obtained in good yield in the present work.

The above results indicate that the reactivity of acetone dicarboxylic acid is similar to that of acetoacetic ester or its α -substituted derivatives. Acetone dicarboxylic acid or its ester may be regarded as χ -substituted

acetoacetic ester $COOH-\overset{\chi}{CH_2}-\overset{\beta}{CO}-\overset{\alpha}{CH_2}-COOH$ the substituent being $-COOH$ or $-COOEt$. It appears from the above results that the introduction of a negative group in χ position does not much affect its reactivity.

EXPERIMENTAL

General Method of Preparing Acetone Dicarboxylic Acid and Its Condensation

Finely powdered citric acid (8 gm.) and concentrated sulphuric acid (10 c. c.) were mixed in a round bottom flask and shaken for half an hour. The mixture was then slowly warmed on water bath to $65-70^\circ$, thermometer dipping into the mixture. Carbon monoxide was given off. The mixture was maintained at the same temperature for about 15 minutes. A pale yellow liquid resulted: it was cooled in ice to lower the temperature below $10^\circ C$. In all the condensations this mixture was used without isolating acetone dicarboxylic acid.

To the above mixture, the substituted phenol (1/30 mol.) and a further quantity of concentrated sulphuric acid (5-7 c. c.) was added and the mixture well shaken taking care to maintain the temperature below $10^\circ C$. The resulting brown-coloured mixture was left overnight in ice box.

The reaction mixture was then treated with ice. A bulky precipitate was obtained : it was collected, washed free from sulphuric acid and digested with NaHCO_3 solution (5%) and filtered. The filtrate was acidified and the solid obtained collected and crystallised from a suitable solvent. All the condensations described in this paper were carried out following the above general method. Hence, the detailed procedure has been omitted to avoid repetitions.

7-hydroxy-6-ethyl-coumarin-4-acetic acid (I : $\text{R}=\text{Et}$; $\text{R}_1=\text{H}$) was obtained from 4-ethyl resorcinol (3.5 g.) according to the general method and crystallised from dilute alcohol, m. p. 206° (efferv.); yield = 2 gms. (Found : C, 63.2 ; H, 4.7. $\text{C}_{13}\text{H}_{12}\text{O}_5$ requires C, 62.9 ; H, 4.83 per cent).

The acid dissolves in NaHCO_3 with intense blue fluorescence with evolution of CO_2 . It is soluble in hot alcohol, boiling water but insoluble in cold.

On heating the acid above its melting point, CO_2 was given off. The residue on purification was identified as 7-hydroxy-6-ethyl-4-methyl coumarin (II : $\text{R}=\text{Et}$; $\text{R}_1=\text{H}$) by direct comparison with an authentic sample prepared by the Pechmann condensation of 4-ethyl resorcinol with acetoacetic ester.

The *ethyl ester* prepared by refluxing the acid-alcohol mixture and a few c.c. of concentrated sulphuric acid, crystallised from alcohol, clusters of thin needles, m. p. $165-66^\circ$ (Found : C, 65.7 ; H, 5.5. $\text{C}_{15}\text{H}_{16}\text{O}_5$ requires C, 65.4 ; H, 5.8 per cent).

The *methyl ester* prepared similarly crystallises from alcohol, lustrous needles, m. p. 159° .

The *acetyl* derivative prepared by acetic anhydride-sulphuric acid method, crystallised from acetic acid, needles, m. p. $182-83^\circ$ (Found : C, 62.4 ; H, 5.2. $\text{C}_{15}\text{H}_{14}\text{O}_6$ requires C, 62.1 ; H, 4.8 per cent).

The *ethyl ester of the acetyl derivative* prepared as above crystallised from acetic acid, needles, m. p. 148° (Found : C, 63.9 ; H, 8.2. $\text{C}_{17}\text{H}_{18}\text{O}_6$ requires C, 64.15 ; H, 5.64 per cent).

The *anilide* formed by the heating the ester with aniline in sealed tube at 160° for about 4 hours, crystallised from alcohol, thin needles, m. p. 169° .

7-hydroxy-6-propyl-coumarin-4-acetic acid (I : $\text{R}=\text{C}_3\text{H}_7$; $\text{R}_1=\text{H}$) prepared according to the general method from 4-propyl resorcinol, crystallised from alcohol, long needles, m. p. $197-98^\circ$ (efferv.) (Found : C, 64.5 ; H, 5.7. $\text{C}_{14}\text{H}_{14}\text{O}_5$ requires C, 64.1 ; H, 5.3 per cent).

The acid exhibits all the properties similar to those of 6-ethyl isomer. On heating the acid, it was decarboxylated : the residue on crystallisation from alcohol was identified with 7-hydroxy-6-propyl-4-methyl coumarin (II : $\text{R}=\text{C}_3\text{H}_7$; $\text{R}_1=\text{H}$).

The *ethyl ester* prepared as before, crystallised from alcohol, plates, m. p. 162-63° (Found : C, 66.5 ; H, 6.3. $C_{16}H_{18}O_5$ requires C, 66.2 ; H, 6.2 per cent).

The *acetyl derivative* of the ethyl ester was similarly prepared, small plates, m. p. 121° (Found : C, 65.3 ; H, 5.8. $C_{18}H_{20}O_6$ requires C, 65.1 ; H, 6.0 per cent).

The *acetyl derivative* of the acid crystallised from acetic acid, m. p. 179° (Found : C, 63.45 ; H, 5.1. $C_{16}H_{16}O_6$ requires C, 63.2 ; H, 5.3 per cent).

The following *coumarin-4-acetic acids* and their derivatives were obtained as in the previous cases. The procedure was also exactly similar. For brevity therefore, they with their melting points and analysis are described without repeating the details :

7-hydroxy-6-chloro-coumarin-4-acetic acid decomposes at 212°. (Found : Cl, 14.2. $C_{11}H_7O_5Cl$ requires Cl, 13.95 per cent).

The acid was de-carboxylated by heating and the residue identified with 7-hydroxy-6-chloro-4-methyl coumarin, m. p. and mixed M. P. 278°.

The *ethyl ester* : needles from alcohol, m. p. 199° (Found : Cl, 12.3. $C_{13}H_{11}O_5Cl$ requires Cl, 12.6 per cent).

The *acetyl derivative* : needles from acetic acid, m. p. 190° (Found : C, 52.3 ; H, 3.25. $C_{13}H_9O_6Cl$ requires C, 52.6 ; H, 3.0 per cent).

The *acetyl derivative* of the ester : plates from dilute alcohol, m. p. 159°.

7-hydroxy-6-bromo-coumarin-4-acetic acid (I : $R=Br$; $R_1=H$) ; Silky needles from boiling alcohol, m. p. 230° decomp.) (Found : Br, 27.1. $C_{11}H_7O_5Br$ requires Br, 26.75 per cent). The acid was heated above its melting point. The residue was identified as 7-hydroxy-6-bromo-4-methyl coumarin by direct comparison, m. p. 280°.

The *ethyl ester* : needles from boiling alcohol, m. p. 206° (Found : Br, 25.0. $C_{13}H_{11}O_5Br$ requires Br, 24.5 per cent).

The *acetyl derivative* : needles from acetic acid m. p. 274°.

The *acetyl derivative of the ethyl ester* : plates from dilute alcohol, m. p. 152-53°.

7-hydroxy-8-acetyl-coumarin-4-acetic acid (I : $R_1=COCH_3$; $R=H$) obtained by the condensation of 2-acetyl-resorcinol crystallised from dilute alcohol, m. p. 183° (effervescence). It gives red colour with alcoholic ferric chloride (Found : C, 59.8 ; H, 3.6. $C_{13}H_{10}O_6$ requires C, 59.5 ; H, 3.8 per cent). It does not give fluorescence but dissolves with yellow colour in alkali. On heating it was decarboxylated to 7-hydroxy-8-acetyl-4-methyl coumarin (Shah and Shah, J., 1938, 1424) m. p. and mixed m. p. 168°.

7-hydroxy-6-carboethoxy-coumarin-4-acetic acid (I : $R = -COOMe$; $R_1 = H$) from methyl β -resorcyate crystallises from alcohol m. p. 185-86° (effervescence) (Found : C, 56.5 ; H, 3.8. $C_{13}H_{10}O_7$ requires C, 56.1 ; H, 3.6 per cent). It gives purple colour with alcoholic ferric chloride and blue fluorescence in alkaline solution. The acid on decarboxylation by heating gives methyl 7-hydroxy-4-methyl coumarin-6-carboxylate (Shah, et al., J. I. C. S., 1937, 14, 717) identified by direct comparison with an authentic sample.

The *ethyl ester* : needles from alcohol, m. p. 195°. Sethna and Shah (*loc. cit.*) give the same m. p.

The *acetyl derivative* : lustrous needles from alcohol, m. p. 206° (Found : C, 56.0 ; H, 3.8. $C_{15}H_{12}O_8$ requires C, 56.25 ; H, 3.75 per cent).

The *acetyl derivative* of the ethyl ester : needles from dilute alcohol, m. p. 148°. Sethna and Shah also give the same m. p.

7 : 8-dihydroxy-6-ethyl-coumarin-4-acetic acid (I : $R = Et$; $R_1 = OH$) obtained by the condensation of 4-ethyl-pyrogallol as before, crystallised from dilute alcohol, lustrous needles, m. p. 202° (decomposition) (Found : C, 59.4 ; H, 5.0. $C_{13}H_{12}O_6$ requires C, 59.1 ; H, 4.5 per cent). It dissolves with deep orange colour in alkali solution as well as concentrated sulphuric acid.

The *ethyl ester* crystallised from alcohol, needles, m. p. 210° (Found C, 61.2 ; H, 5.8. $C_{15}H_{16}O_6$ requires C, 61.65 ; H, 5.5 per cent).

The *diacetyl derivative* crystallised from acetic acid, plates, m. p. 173-74° (Found : C, 58.2 ; H, 4.8. $C_{17}H_{16}O_8$ requires C, 58.6 ; H, 4.6 per cent).

The *acetyl derivative* of the ethyl ester, needles, m. p. 94-95°.

The acid on heating was de-carboxylated to 7:8-dihydroxy-6-ethyl-4-methyl coumarin, m. p. 202°, identified by direct comparison.

7:8-dihydroxy-6-carbomethoxy-coumarin-4-acetic acid obtained by the condensation of methyl pyrogallol-4-carboxylic ester crystallised from alcohol needles, m. p. 271° (Found : C, 54.1 ; H, 4.0. $C_{14}H_{12}O_8$ requires C, 54.5 ; H, 3.9 per cent). It gives dark green colour with alcoholic ferric chloride, and dissolves in alkali with deep yellow colour.

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A STUDY OF THE OILS FROM THE SEEDS OF

- (1) *Luffa Aegyptiaca* } N. O. : *Cucurbitaceæ*
 (2) *Beninkasa Ceriferra* }

By K. D. PHADNIS, A. V. REGE, D. G. PISHAWIKAR AND S. V. SHAH

THE plant, *Luffa Aegyptiaca* (Eng : Smooth Luffa *6 Wash sponge* : Marathi : *Ghosawala*) is a hairy climbing herb extensively cultivated in several parts of India. Fruit is twelve to thirty centimeters long, smooth and cylindrical. Seeds are black or grey, smooth and slightly tuberculate.

The plant *Beninkasa Ceriferra* (Eng: White gourd Melon: Marathi: Kohala) is cultivated throughout India. It resembles pumpkin in appearance. The fruit is thirty to forty five centimeters long hairy and ultimately covered with a waxy bloom.

The seeds for the present investigation were obtained from the immediate neighbourhood of Kolhapur. The seeds were extracted with petroleum ether after decortication and the yield was calculated on this basis. Last traces of the solvent were removed under reduced pressure. A dark red oil was obtained in the case of *Luffa Aegyptiaca* and a pale yellow oil in the case of *Beninkasa Ceriferra*.

TABLE NO. I: PHYSICAL AND CHEMICAL CONSTANTS

	<i>Luffa Aegyptiaca</i> *	<i>Beninkasa Ceriferra</i>
Yield	40.0 per cent	36.4 per cent
Specific gravity	0.9412 at 27°C	0.9234 at 30°C
Refractive Index	1.4830 „ „	1.4740 „ „
Saponification Value ..	194.90	194.45
Iodine Value	106.40	135.25
Acid Value	7.99	1.47
Acetyl Value	17.95	20.49
Reichert-Meissl	0.5878	0.498
Polenski Number	1.18	1.205
Unsaponifiable Matter ..	1.2 per cent	1.31 per cent

The Insoluble Fatty Acids : The oils were saponified with alcoholic potassium hydroxide and the soaps were dried and washed with ether to remove the unsaponifiable matter. The fatty acids were liberated

Specific gravity (at 15°C) 0.921 to 0.926 :
 Saponification Value 193 to 195.8.
 Iodine Value 102.3 to 113.6 : Acid value.. 30 to 36.4
 (Hooper : Annual Report, Indian Museum, 1907 ; 1908, Page 13)

by acidifying the soaps with hydrochloric acid. The liberated fatty acids were then extracted with ether and washed free from hydrochloric acid. The ether extract was then dried over anhydrous calcium chloride and filtered. The ether was distilled off and the mixed fatty acids thus collected, gave the following values :

TABLE NO. II: MIXED FATTY ACIDS

	<i>Luffa Aegyptiaca</i>	<i>Beninkasa Ceriferra</i>
Yield	93·10 per cent	93·50 per cent
Iodine Number	112·30	142·25
Acid Number	197·50	198·70
Mean Molecular Weight (calculated from above)	283·20	281·90
Titre Value	34·33°C	....

Separation of the Fatty Acids : The separation of the solid (saturated) and liquid (unsaturated) fatty acids was affected by Twitchell's lead salt method by the fractional precipitation of the lead salts of the fatty acids with lead acetate.

TABLE NO. III : SEPARATION OF THE FATTY ACIDS

<i>Luffa Aegyptiaca</i>					
	Gms.	Ist Crop	IIInd Crop	IIIrd Crop	Total
Mixed Fatty acids(taken)	38·4				
Solid acids (obtained) ..	....	4·2 gm.	1·8 gm.	0·5 gm.	6·5 gm.
Melting Point .. ..	....	58°C	57°C	57°C	58°C
Neutralisation Value ..	....	209·0	209·4	210·1	209·5
Mean Molecular Weight	....	268·4	268·0	267·1	267·85
Iodine Value .. ..	....	....	....	....	3·11
Thus, total Solid Acids(obtained) ..		Grams		Percentage	
.....		6·5		16·93	
Liquid Acids		31·9		83·07	

<i>Beninkassa Ceriferra</i>					
	Gms.	Ist Crop gms.	IIInd Crop gms.	IIIrd Crop gms.	Total Acids gms.
Mixed Fatty acids(taken)	48·0				
Solid acids (obtained) ..	....	2·8	1·9	1·4	6·1
Melting Point .. ..	....	57°C	56°C	56°C	57°C
Neutralisation Value ..	....	212·4	212·7	213·2	212·8
Mean Molecular Weight	....	264·2	263·8	263·2	263·75
Iodine Value .. ..	....	....	....	....	4·32
Thus, total Solid Acids(obtained) ..		6·1 gms : i.e.		12·52 per cent	
Liquid Acids		41·9 gms : i.e.		87·48 per cent	

The solid (saturated) acids as obtained above, were then, turned into their methyl esters, by refluxing the acids with methyl alcohol saturated with dry hydrochloric acid gas. The esters were finally distilled under reduced pressure (2 mm to 8 mm).

TABLE NO. IV : (a) *LAFFA AEGYPTIACA*

Fraction	B. P.	Weight of Methyl Esters	Saponification Value	Mean Molecular Weight
1	up to 180°C	3.1330 gms.	207.2	271.0
2	180°C-185°C	4.3011 gms.	203.7	275.1
3	185°C-190°C	2.1180 gms.	201.4	277.3
4	190°C-193°C	2.1950 gms.	199.9	282.2
3	193°C-195°C	1.9211 gms.	191.1	292.8
6	195°C onwards	3.5200 gms.	188.8	296.5
	Total ...	17.2942 gms.		

TABLE NO. IV : (b) *BENINKASSA CERIFERRA*

Fraction	B. P.	Weight of Methyl Esters	S. V.	Mean Molecular Weight
1	up to 165°C	1.4205 gms.	206.7	271.1
2	165°C-170°C	4.1200 gms.	203.3	275.7
3	170°C-175°C	1.4502 gms.	202.5	278.2
4	175°C onwards	1.8221 gms.	199.9	282.2
5	Residue	0.8622 gms.		
	Total ...	9.6750 gms.		

Each of these fractions of the methyl esters was hydrolysed separately by potassium hydroxide and the corresponding fractions of the fatty acids were obtained by acidifying the soaps with hydrochloric acid. Mean molecular weights and melting points of the different fractions corresponding to the fractions of the methyl esters in Table No. IV, are given in the following table :

TABLE NO. V : (a) LUFFA AEGYPTIACA

Frac- tion	M. P.	Wt. of Acids (cor- responding to the esters Table No. IV)	Neutra- lisation Value	Mean Mol. Wt.	Percentages of	
					Palmitic	Stearic
1	59°C	2.98 gm.	217.9	257.5	94.64	5.36
2	57°C	4.10 gm.	214.4	261.7	79.64	20.36
3	57°C	2.30 gm.	211.9	264.9	68.21	31.79
4	57°C	2.10 gm.	208.1	269.3	52.50	47.50
5	64°C	1.83 gm.	201.6	278.2	20.71	79.29
6	68°C	3.20 gm.	198.3	282.8	4.29	95.71

TABLE NO. V : (b) BENINKASSA CERIFERRA

1	59°C	1.35 gm.	218.2	257.1	96.07	3.93
2	57°C	3.92 gm.	214.4	261.6	80.0	20.0
3	56°C	1.38 gm.	211.1	265.6	65.71	34.29
4	57°C	1.78 gm.	208.2	269.1	53.21	46.79
5	68°C	0.82 gm.	197.7	283.6	1.43	98.57

The free acids thus obtained from the methyl esters were further separated into individual acids by fractional precipitation of their magnesium salts. Acids were recovered from the magnesium salts and crystallised from alcohol. In all the cases only palmitic and stearic acids were obtained, and no other acid was detected. Hence on this basis the proportions of the palmitic and stearic acids were calculated.

From these tables the approximate percentages of the individual acids (Stearic and Palmitic) in the solid portion were calculated.

	<i>Luffa Aegyptiaca</i>	<i>Beninkassa Ceriferra</i>
Palmitic Acid :	56.15 per cent	68.11 per cent
Stearic Acid :	43.85 „	31.89 „
Constituting	16.93 per cent of the total fatty acids	12.52 per cent of the total fatty acids

Unsaturated (Liquid) Acids : After the removal of the solid fatty acids as insoluble lead salts of the saturated acids, the liquid acids were liberated with dilute hydrochloric acid from their lead salts and extracted with ether. They were washed and dried over calcium chloride. On removing the ether the liquid fatty acids were recovered. The acids thus obtained gave the following values :

TABLE NO. VI : UNSATURATED (LIQUID) FATTY ACIDS

	<i>Luffa Aegyptiaca</i>	<i>Beninkassa Ceriferra</i>
Specific Gravity(32°C) ..	0.9212	0.9034 (at 25°C)
Refractive Index „ ..	1.4690	1.4660 „
Iodine Value	135.4	159.45
Neutralisation Value ..	195.3	197.80
Mean Molecular Weight	286.1	283.1

Bromination of the Liquid Fatty Acids : 10-13 grams of the liquid acids were dissolved in ether (sulphuric) and the solution was cooled in ice. A cold solution of bromine in the same solvent was then gradually added to the solution of the liquid fatty acids with constant stirring. The reaction mixture was then left overnight in ice-box. Next day no solid bromo-derivative was observed. The ether was removed and the excess of bromine was further removed washing with dilute solution of sodium thiosulphate. The liquid mass obtained after washing with water was mixed with petroleum ether and rubbed for some time, when a white solid derivative began to separate. The solid bromo-derivative thus obtained was washed with petroleum ether and filtered off. From the filtrate and the washing the liquid bromo-derivative was obtained on removing the petroleum ether. The results are given in the following table :

*Luffa Aegyptiaca**Bromination of Liquid Acids*

12.64 grams of the liquid fatty acids were taken for bromination.

	Tetra-bromide gms.	Corresponding to Linolic Acid	Di- bromide	Corresponding to Oleic Acid
Yield:	13.2	6.16	9.5 gm.	6.06 gm.
M. P.	114°C		Liquid	

	Tetra-bromide	Di bromide
Bromine Content :	53.0 per cent (Found) 53.33 „ (Required)	37.21 per cent (Found) 36.18 „ (Required)

Beninkassa Ceriferra : Bromination of Liquid Acids
10 gms. for bromination

	Tetra-bromide	Corresponding to Linolic Acid	Di-bromide: Corresponding to Oleic Acid
Yield:	15.3 gm.	7.14 gm.	4.9 gm. (mixture of tetra and di-bromides)
M. P.	114 C		Liquid
Bromine Contents:	52.75 per cent (Found) 53.33 „ (Required)		12.11 per cent (Found) 36.18 „ (Required)

Calculating from the bromine content (42.11 per cent) of the di-bromide obtained, 1.9 gms. of the bromo-derivative corresponds to :

Tetra-bromide	Corresponding to Linolic Acid	Di-bromide	Corresponding to Oleic Acid
1.47 gm.	0.686 gm.	3.43 gm.	2.09 gm.

Hence, the percentages of the linolic and oleic acids, present in the liquid acids (calculated from the above results) are given below :

	<i>Luffa Aegyptiaca</i>	<i>Beninkassa Ceriferra</i>
Linolic acid :	51.27 per cent	78.26 per cent
Oleic acid :	48.73 „	21.90 „
Constituting ..	83.07 „ of the total mixed fatty acids	87.48 „ of the total mixed fatty acids

Summing up, the total insoluble fatty acids in the oils are :

	<i>Luffa Aegyptiaca</i>	<i>Beninkassa Ceriferra</i>
Total Solid (saturated) Acids ..	16.93 per cent	12.52 per cent
Palmitic Acid	9.58 „	8.53 „
Stearic Acid	7.35 „	3.99 „
Liquid (unsaturated) Acids ..	83.07 „	87.48 „
Linolic Acid	42.58 „	68.32 „
Oleic Acid	40.49 „	19.16 „

Unsaponifiable matter : The unsaponifiable matter was obtained from the ethereal washings of the dry soaps, after thoroughly washing the ether solution with water to remove any dissolved soap. A white solid compound was obtained (in both the cases), which melted at 144 C-148°C. Usual colour reactions of characteristic to phytosterol were also obtained.

One of us (S. V. S.) thanks the University of Bombay for a research grant in this connection.

(3) **ALLIUM CEPA** (N. O. *Liliaceæ*)

THE Plant-*Allium Cepa* (Eng. : Onion, Hindi : Pyaj, Marathi : Kanda) is cultivated all over India. It is a perennial plant with thick bulb. The bulbs contain an acrid volatile oil which contains sulphur. Onions are largely used as an article of food. The seeds are black and very hard and yield a yellowish oil which is used in medicine.

The seeds were collected from the neighbourhood of Kolhapur and were extracted with petroleum ether in a soxhlet and the last traces of the solvent were removed by distillation under vacuum, when a pale yellow oil was obtained.

TABLE NO. 1 : PHYSICAL AND CHEMICAL CONSTANTS

Yield	..	..	..	..	..	..	20%
Specific Gravity (25°C)	..	..	..	..	..	..	0.9364
Refractive Index (25°C)	..	..	..	..	..	..	1.4860
Saponification Value	..	..	..	..	..	..	188.5
Iodine Value	..	..	..	..	..	..	118.2
Acid Value	..	..	..	..	..	..	2.88
Acetyl Value	..	..	..	..	..	..	19.6
Reichert-Meissl Value	..	..	..	..	..	..	0.599
Polenske No.	..	..	..	..	..	..	1.17
Unsaponifiable Matter	..	..	..	..	..	..	1.8%

The Insoluble Fatty Acids : The oil was saponified by alcoholic potassium hydroxide and the soaps were dried and extracted with ether to remove the unsaponifiable matter. The free fatty acids were liberated by acidifying the soaps with hydrochloric acid (dilute). The acids liberated were taken up with ether and the ether extract was washed free from hydrochloric acid. The ether solution was then dried over anhydrous calcium chloride and filtered. The ether was distilled off and the mixed fatty acids thus obtained gave the following results :

TABLE NO. 2 : MIXED FATTY ACIDS

Yield	..	..	..	..	..	..	96.5%
Specific Gravity (28°C)	..	..	..	..	..	..	0.9050
Refractive Index (28°C)	..	..	..	..	..	..	1.4780
Iodine Value	..	..	..	..	..	..	121.45
Acid Number	..	..	..	..	..	..	197.1
Hence Mean Molecular Weight	..	..	..	..	..	..	283.9

Separation of the Fatty Acids : The separation of solid (saturated) and liquid (unsaturated) acids was effected by Twitchell's lead salt method by precipitation of the solid fatty acids with lead acetate in alcoholic solution.

TABLE NO. 3 : SEPARATION OF THE FATTY ACIDS

	Ist Crop	IInd Crop
Mixed Acids (taken) 25.2 gms. ..	0.6 gm.	0.48 gm.
Solid Acids (obtained)	54.5°C	53°C
Melting Point	54.5°C	53°C
Acid Number	210.0	211.1
Mean Molecular Weight	266.7	265.3
Iodine Value	3.14	3.59
Thus, Total Solids Acids (obtained) ..	1.08 gm. <i>i.e.</i>	4.38%
„ Liquid Acids („) ..	24.12 gm. <i>i.e.</i>	95.62%

As the percentage of the oil from the seeds is small (20%) and the percentage of the solid acids is still less *i.e.* only 4% of the total mixed acids, an attempt was made to separate the constituent acids by fractional crystallisation from acetone and methyl alcohol. Repeated fractional crystallisation showed no change in the melting point (55°C) of any one of the fractions and also the molecular weight remained the same (264°-266°).

Mixed melting points gave the following results with authentic samples of myristic, palmitic and stearic acids :—

Melting Point of Solid Acids (original)	54°C
„ „ with Myristic Acid (M. P. 54°C)	48°C
„ „ „ Palmitic „ („ 62°C)	57°C
„ „ „ Stearic „ („ 69°C)	60°C

The depression in the melting point with myristic acid and the acids (solid) having molecular weight 265°-266° (as against 228° of myristic acid), indicate very little possibility of myristic acid being present as one of the constituent acids of the mixture.

Another attempt to separate the individual acids was made by preparing their magnesium salts and fractional crystallisation of each crop on lines similar to that of the lead salt method.

The solid acids were dissolved in absolute alcohol and neutralised by potassium hydroxide and magnesium salts were obtained, using magnesium acetate in smaller fractions (from 0.5 to 0.2 gm. for 6.5 gms. of solid acids in this case); into different crops. Each crop of acids liberated from magnesium salts was fractionally crystallised from methyl alcohol when following results were obtained.

6.5 gms. of the Solid Acids were fractionally precipitated by Magnesium acetate in the usual manner.

Crop	Ppt. A		Ppt. B		Ppt. C	
	I	II	I	II	I	II
Wt. of Acids ..	0.300 gms.	1.00 gm.	0.83 gm.	0.64 gm.	0.32 gm.	1.21 gm.
M. P. ..	65-67°C	65-67°C	54.5°C	51°C	59-60°C	59-60°C
Mean Mol. Wt. ..	278-280				258-259	

From the above results it can be seen that the first fraction A consists of Stearic acid with traces of palmitic acid and the first fraction C contains only Palmitic acid with traces of Stearic acid. From the intermediate fraction B only Palmitic and Stearic acids could be isolated.

The percentages of Palmitic and Stearic acids on this basis calculated from the mean Mol. wt. (266) of the solid acids worked out as :-

Palmitic Acid ... 64.28% Stearic Acid ... 35.72%

From this melting point of solid acid (51° to 55°C) the same percentages should lie within the limits of 67-70% of Palmitic acid and 33 to 30% of Stearic acid.

Unsaturated (liquid) Acids : After the removal of the solid acids as insoluble lead salts of the saturated acids, the liquid acids were liberated with dilute hydrochloric acid from their lead salts and extracted with ether. They were washed and dried over anhydrous calcium chloride. The acids thus obtained gave the following values:—

TABLE NO. 5 : UNSATURATED (LIQUID) FATTY ACIDS

Sp. gravity at 29°C ..	..	..	..	..	0.9014
Refractive Index at 29°C ..	..	..	..	..	1.4720
Iodine Value ..	..	..	..	..	126.5
Acid Number ..	..	..	..	..	197.5
Hence Mean Molecular Weight	..	..	..	..	283.7

Bromination of Unsaturated Acid : 10.12 gms. of the Liquid Acids were dissolved in ether (sulphuric) and kept in ice. Bromine was dissolved separately in ether and cooled in ice and added gradually with constant stirring. The flask was kept over night. Next day no solid compound was observed indicating the absence of hexabromide. The ether was distilled off and the excess of bromine was washed completely with dilute solution of sodium thiosulphate. The remaining liquid compound was taken up with petroleum ether and rubbed for a long time when a white solid compound was separated. It was filtered, washed with petroleum ether and dried.

Yield ... 8.63 gms. M. P. 114°C (on crystallisation)
 Corresponding to 4.3 „ Linolic acid.

Bromine Content (found) 52.97%
 „ (required) 53.33%

From the filtrate the petroleum ether was then completely removed when a red viscous oil was obtained.

Yield ... 9.20 gms.
 Corresponding to 5.87 „

Bromine Content (found) 36.65% (Oleic acid)
 „ (required) 36.18

Thus, total liquid acid taken	..	..	..	10.12 gms.
Linolic acid	..	..	..	4.03 „
Oleic	„	..	..	5.87 „
Loss	..	..	..	0.22 „

On this basis the percentages of

Linolic acid	..	..	..	39.82%
Oleic acid	..	..	..	60.18%

Summing up, the total insoluble fatty acids in the oil are :

Solid (Saturated) Acids (1.38 per cent)	|	Palmitic acid ..	2.815%
	|	Stearic „ ..	1.565%
Liquid (unsaturated) Acids (95.62 per cent)	|	Linolic acid ..	38.07%
	|	Oleic „ ..	57.55%

Unsaponifiable Matter : The ethereal washing of the soap after saponification was washed with water completely, to remove any dissolved soap.

A white solid compound was separated crystallised from alcohol which melted at 110°C.

This unsaponifiable matter gave all the colour reactions characteristic of common phytosterols.

One of us (S. V. S.) thanks the University of Bombay for a research grant in this connection.

NOTES AND NEWS

COPY OR ORIGINAL ?

15TH AUGUST 1947 will always be considered as a red-letter day in the history of the world, since on that day a big country like India with a population of millions of people became independent without shedding a drop of blood. The technique followed to bring about this result was not the employment of the usual physical force supported by vast mechanized armies on land and in air, over and under water, but of the soul force the outer manifestations of which were truth and non-violence, voluntary suffering and sacrifice. This teaching initiated by Gandhiji was in a line with the Indian genius and ancient Indian traditions.

Now that our country has become free and attained the power of managing her affairs according to her own ideals, the question which she has to decide is whether she wants to follow her own unique genius and ancient traditions which made the country great, prosperous and respected in the past all over the world, *or* whether she wishes to *copy* the technological civilization and follow the technique which the Western nations have been following. In other words, our country has to decide and she must be very clear in mind on this subject whether the new Indian civilization is to be based on spiritual foundations, that is, on the highest ethical principles and knowledge of the Laws of Life as of old, *or* whether she wants to go in for a purely materialistic, technological, militaristic civilization which the Western countries are elaborating on a large scale at present. In deciding this question, our country should not forget that under the aegis of the technological civilization which grew at random under the leadership of politicians, financiers, capitalists and industrialists, two terrible world wars have taken place within a generation which have brought the whole world to a verge of starvation, misery, suffering, frustration and despondency which it had never experienced before and from which she has not yet become free.

It must be borne in mind that spiritual culture does not exclude material civilization. In such a culture, higher values in life are given the first place and material pursuits are not ignored but given their rightful place which is next to the spiritual. In the materialistic civilization, on the other hand, higher values in life are ignored, neglected or forgotten altogether; they are not given the first place which is their due.

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When we were under the foreign rule our chief complaint against our rulers was the very heavy expenditure on the military department which necessitated the starving of nation-building departments. We were under the impression that when our country attains her freedom and manages her own affairs she will see that this heavy expenditure on the military department will be considerably reduced. Of course, the

maintenance of a sufficiently big and efficient military police force and home guards for keeping internal peace is absolutely necessary. Our policy is not one of aggression. That has been announced times out of number by our Premier and leading statesmen. Under the circumstances, the pronouncement recently made by the Deputy Premier of our country that owing to change of conditions, there will be an increase in, and expansion of, the military forces on land, water and air, and therefore a consequent increase in the military expenditure, has come as a surprise. This means a change of policy. Is it the change of conditions which has brought about this change of policy or is it the change of mentality which has brought about this result? On the one hand, in season and out of season, the life and teachings of Gandhiji are held up before the people and they are asked to follow them. And on the other, Gandhiji's greatest teaching the following of which under his direction won freedom for the people without shedding a drop of blood and brought the country in the limelight before the whole world, is not followed by Government themselves. One wonders what effect this change of policy will have on the people!

Is our Government afraid of an attack by a foreign government that she has thought fit to change her policy? Could she not use the same superior weapon of soul force against her enemies which brought freedom to her from the mighty British rulers? Would she not like to develop this new technique given to her by Gandhiji and give it as a gift to the nation and the whole world? Every country has some contribution or other to make to the world culture to bring about peace and happiness. What shall be India's contribution? Of all the countries in the world, is not India the fittest country to make this spiritual contribution to the culture of the world so that the whole world becomes *ONE* world and all the peoples of the world live as members of *ONE* family. If India loses this opportunity then the prospects for the world are very dark indeed. All the countries of the world look up to India to guide them to this goal of brotherhood.

It is therefore very necessary for the leaders of our country to have the goal clearly before them. Do they wish our country to be a great industrial country; do they wish her to be great in her scientific and technological achievements and military science so that she may strike terror in the hearts of all the foreign rulers who may cast their evil eyes on her; or, do they wish the Government of the country to be the most efficient and therefore have as their goal the production of highly efficient clerks, collectors and commissioners; or, do they wish her to be great in arts and handicrafts; or, do they wish to lay emphasis on the higher values of life which by no means ignore the material values but give them a secondary place?

As a great sage has said: "The world stands at the threshold of a new era, a new departure, and at such a time, as ever before, the direction of the first step determines the direction of the new departure. An error in the direction of the first steps affects the whole of the succeeding ones". Let India rise to the supreme opportunity at this critical period in the history of the world and play the unique part to guide the world along right spiritual lines for which she is best fitted and destined.

D. D. KANGA

BOOK REVIEW

Indian Journal of Dairy Science, Vol. 1, Nos. 1 & 2. Published by the Indian Dairy Association, Bangalore. Rs. 12-0-0 per annum.

THE scientific world will welcome in its midst the appearance of a new periodical—the “Indian Journal of Dairy Science”. It is a quarterly organ of the Indian Dairy Science Association and will be devoted to the advancement and dissemination of knowledge in regard to Dairy Science in all its aspects. The publication of this new scientific journal is “the outcome of a long-felt desire on the part of all persons concerned with Dairy Science in India to find a satisfactory medium of expression to cover the large and growing developments in the science and practice of dairying in this country and to serve as a link between scientific workers engaged in different parts of the world”.

The first issue which is before us is a well got-up number and contains six research papers on different subjects connected with dairy science and industry. We hope the journal will fill a gap in our scientific research literature and fulfil the objects for which it has been brought out and advance the cause of dairy science and industry. We further hope that it will receive a cordial and sympathetic co-operation of research workers, scientific institutions and organisations connected with the dairy industry and the enlightened public. We wish this new periodical a long and useful career.

—D. D. K. (BOMBAY)

LIST OF THESES

Table showing M.Sc., M.Sc. (Tech.), Ph.D. and Ph.D. (Tech.) in Physics, Chemistry, Technology, Textile Chemistry, Dye-stuffs and Chemical Engineering (from October 1947 to September 1948).

Name of the Candidate	Subject of the Thesis	Name of the Professor under whom the Candidate Worked	Name of the Institution
	M.Sc. Physics		
Bhatia, N. S.	Dielectric Constants of Pure Liquids and Concentrated Solution and Dipole Moments	Professor S. G. Khubchandani	D. J. S.
Hattiangadi, M. S. R.	Wireless (Atmospheric Electricity) Investigations on the properties of the Ionosphere by studying wave-forms of Atmospheric	Dr. M. W. Chiplonkar	Sir P.
	Chemistry		
Anjaria, T. D.	The Decomposition of Fatty Acids	Dr. N. R. Damle	Dept. of Industries
Badami, R. C.	I. Chemical Examination of the Seeds of <i>Citrullus colocynthis</i> , Schrader (N. O. Cucurbitaceae); II. Chemical Examination of the Seeds of <i>Jatropha Glandulifera</i> Roxb; III. Chemical Examination of the Essential Oil from the Leaves of <i>Mentha Piperita</i>	Professor R. L. Alimchandani	K. C.
Basu, S. M.	Studies on Indian (1) Shark Liver Oils and (2) Lemon Grass Oils	Dr. V. Subrahmanyam	I. I. Sc.
Bhagwat, R. V.	Part I—Studies of Substituted Crotono-Lactones A New Method for the Synthesis of Substituted Crotono-Lactones; Part II—Condensation of Acetone-di-carboxylic Acid with (a) Ethers of β Naphthol and (b) Resorcinol Dimethyl Ether	Professor V. M. Bhawe	R. N. R.
Bharani, S. P. (Miss)	Part I—Some Metabolic Aspects of Vitamin B—Complex primarily Nicotinic Acid and Part II—The Probable effect of Strain on the Ash and Mineral Contents of Certain Cereals and Pulses	Dr. R. G. Chitre	G. S. M.
Biradar, N. S.	Magnetic Study of Some Hydrates	Dr. Mata Prasad	R. I. Sc.
Dalal, L. H. (Miss)	Studies in Synthetic Insecticides	Dr. R. C. Shah	R. I. Sc.

Name of the Candidate	Subject of the Thesis	Name of the Professor under whom the Candidate Worked	Name of the Institution
Desai, D. B.	Studies in Essential Nutrients with special reference to Nicotini Acid and Carolene	Dr. R. G. Chitre	G. S. M.
Desai, M. N.	(A) Study of the Rate of Hydrolysis of Acetyl Substituted Areas and Acetyl Urethane. (B) Bromination of Acetyl Substituted Ureas	Professor C. M. Desai	M. T. B.
Dipali, N. I.	Some Reactions of Hyponitrites and Nitrites	Professor T. M. Oza	K. C.
Dwivedi, S. M.	Some Attempt to make out the Mechanism of Chemical Reactions. (A) Thermal Decomposition of (i) Barium Nitrite and (ii) Barium Nitrate. (B) Action of Charcoal on (i) Barium Nitrate and (ii) Lead Nitrate	Professor M. S. Shah	G. C.
Ghose, A. K.	The Diamagnetic Susceptibilities of Mercurous and Murcuric Ions	Dr. Mata Prasad	R. I. Sc.
Iyer, R. S.	Studies in Oxidations with Sodium Perborate	Professor S. M. Mehta	R. I. Sc.
Jassawalla, J. P.	Behaviour of Metallic Soaps Towards Non-Aqueous Media	Dr. Mata Prasad	R. I. Sc.
Joshi, D. V.	Studies in Sulphonylchlorides and Acid Chlorides	Dr. R. C. Shah	R. I. Sc.
Joshi, P. N.	Studies in Starches and Starch Splitting Enzymes	Professor V. Subrahmanyam	I. I. Sc.
Kshatriya, K. C.	Synthetic Antimalarials	Dr. K. S. Nargund	G. C.
Kulkarni, B. A.	Studies in the Preparation and Properties of Colloidal Graphite	Dr. B. K. Vaidya	U. D. C. T.
Lajmi, V. R.	Studies in the Solubilities of Titania and Alumina in Solutions of Alkali Hydroxides	Professor S. M. Mehta	R. I. Sc.
Lakshman Rao	Modification of Vegetable Oils	Dr. J. G. Kane	U. D. C. T.
Lele, A. M.	Part I—Synthesis of (i) 4-methyl-2'-Phenyl Coumarin (7-8)- γ -Pyrone and (ii) 4-Methyl-2'-Phenyl-Coumarin (7-8) Dihydro- γ -Pyrone. Part II—Synthesis of 3-Methyl(-5':6-Furo-Flavine, Part III—Synthesis of 4-Chloro-2-Acetyl-Resorcin by the Extension of the Nidhone Process	Professor S. D. Limaye	R. I. E. I.

Name of the Candidate	Subject of the Thesis	Name of the Professor under whom the Candidate Worked	Name of the Institution
Madan, D. S.	.. Studies in Adsorption of Acids by Wool	Professor V. V. Nadkarny	St. X.
Mainkar, V. B.	.. Potentiometric Studies of Oxidation—Reduction systems	Dr. S. K. Kulkarni-Jatkar	I. I. Sc.
Marathe, K. G.	.. Syntheses of 2 (?) Bromo-3-Methyl-4"-Methoxy-5' : 6"-Furo-Flavone and 2 (?) Bromo-3-Methyl-5:6-Furo-Flavone	Professor S. D. Limaya	R. I. E. I.
Motiwalla, D. K.	.. Anthelmintics	Professor M. L. Khorana	U. D. C. T.
Paranjpe, V. K.	.. Part I—Studies in the Synthesis of Antirachitic Substances. Part II—Studies in Synthetic Anthelmintics	Professor B. V. Bhide	Sir P.
Patankar, A. D.	.. Studies on the Electrochemical Preparation of Ethylene Chlorohydrin and Ethylene Glycol	Dr. S. K. Bhattacharya	I. I. Sc.
Patel, C. C.	.. Studies on the Electrochemical Preparation of Sodium Hydro-Sulphite	Dr. M. R. Aswatha Narayan Rao	I. I. Sc.
Patel, S. R.	.. Synthetic Antimalarials	Dr. K. S. Nargund	G. C.
Phadnis, K. D.	.. Studies in Some Vegetable Oils from Seeds of Plants found in round about Kolhapur	Dr. S. V. Shah	R. C.
Phatak, S. S.	.. Cryoscopic Studies in Some Indian Edible Oils	Principal D. D. Karve	F. C.
Rajadhyaksha, K. K.	Study of Milk and Milk Fat of Ass	Rao Bahadur D. L. Sahasrabuddhe	N. W. C.
Renato da Penha Goncalves	Studies in Viat and Mordant Dyes	Professor V. V. Nadkarny	St. X.
Ribeiro, D. J.	.. A Systematic Study of Curcuma Longa	Professor V. V. Nadkarny	St. X.
Sathe, M. V.	.. Studies in Food Stuffs—A Study of Comparative Disintegration of Rala and Harik	Professor N. V. Bhide	N. W. C.
Shah, C. J.	.. Study of the Reactivity of the Hydrogens of the Methylene group ($-\text{CH}_2-$) in the Substituted Amides of Malonic Acid and Formation of their Iodo Derivatives.	Professor M. D. Avasare	B. C.
Shah, D. N.	.. Studies in Fries Migration	Dr. N. M. Shah	G. C.
Shroff, P. D.	.. Fermentative Production of Citric Acid	Professor A. Sreenivasan	U. D. C. T.

Name of the Candidate	Subject of the Thesis	Name of the Professor under whom the Candidate Worked	Name of the Institution
Vyas, G. N.	.. Synthesis of Hydroxy Chalkones <i>M.Sc. (Tech.) Technology</i>	Dr. N. M. Shah	G. C.
Bhende, S. V.	.. Experiments in Mineral Khaki	Dr. S. R. Ramachandran	U. D. C. T.
Bhujang, K. S.	.. A Study of the Properties of Oxycellulose	Dr. G. M. Nabar	U. D. C. T.
Daruwalla, E. H.	.. Studies in the Inhibition of the Precipitation of the Hydroxides of Iron and Chromium in Presence of Caustic Soda	Dr. G. M. Nabar	U. D. C. T.
Lad, S. M.	.. Reactions Under Pressure with Carbon Dioxide in Non-Aqueous Media	Dr. G. P. Kane	U. D. C. T.
Pandya, Y. M.	.. Preparation of Sulphur Dyes from Benzene and Naphthalene Derivatives	Dr. R. D. Desai	U. D. C. T.
Patel, S. M.	.. Studies in Indian Shark Liver Oil <i>Textile Chemistry</i>	Dr. A. Sreenivasan	U. D. C. T.
Shah, B. V.	.. Part I—Studies in Basic and Alidic Dyes; Part II—Preparation of Some Insecticides <i>Dye-Stuffs</i>	Dr. R. D. Desai	U. D. C. T.
Bedekar, V. D.	.. Studies in the Manufacture of Azo Dyes <i>Chemical Engineering</i>	Dr. R. D. Desai	U. D. C. T.
Joglekar, M. A.	.. Reactions with Carbon Dioxides—Utilization of Sodium Sulphate <i>Ph.D. Chemistry</i>	Dr. G. P. Kane	U. D. C. T.
Adarkar, S. P.	.. Soap Gels in Non-Aqueous Media	Dr. Mata Prasad	R. I. Sc.
Iyengar, B. R. I.	.. Dielectric Constants of Liquids and Solids.	Li-Dr. S. K. Kulkarni-Jatkar	J. I. Sc.
Modak, T. N.	.. Azoic Dyes: Part I—Naphthols Derived from β Hydroxynaphthoic Acid; Part II—(a) Synthesis of Arylides of β Ketone Acids, (b) Coupling Behaviour of Yellow-producing Naphthols; Part III—Abnormal Coupling	Dr. K. Venkataraman	U. D. C. T.

Name of the Candidate	Subject of the Thesis	Name of the Professor under whom the Candidate Worked	Name of the Institution
Patwardhan, S. V.	Study of Changes in Charge and Absorption of Methylene Blue and Crystal Violet by Cotton and Silk Fibres	Dr. Mata Prasad	R. I. Sc.
Rajagopalam, R. A.	Investigations on Sewage Farming	Professor V. Subrahmanyam	I. I. Sc.
Rama Sharma, G. B.	Studies on Pro-Vitamins A. (1) Effect of Coconut Cake on Carotene Absorption by Rats ; (2) Absorption of β Carotene by Vitamin A—deficient rats; (3) A Chromatographic absorption method for estimating of pro-vitamin A ; (4) Carotinoid Pigments of Badami Mango Fruit	Dr. A. Sreenivasan	U. D. C. T.
Rangappa, K. S. ..	Studies in Milk and Butter fat with special reference to the detection of adulteration in Milk and improved methods of the Production of Butter fat by the Indigenous Process	Professor V. Subrahmanyam	I. I. Sc.
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Munshi, S. K. ..	Surface Active Chemotherapeutics	Dr. K. Venkataraman	U. D. C. T.
Savur, Gopalrao ..	Characterization of Pectins	Dr. A. Sreenivasan	U. D. C. T.
Sen, A. ..	The Nature and Distribution of Soluble Salts in Indian Soils	Dr. S. V. Desai	I. A. R. I.
	<i>Technology</i>		
Parekh, N. N. ..	Studies in the Colloidal Properties of Some Indian Clays	Dr. B. K. Vaidya	U. D. C. T.
Rau, S. J. ..	Industrial Amylases	Dr. A. Sreenivasan	U. D. C. T.
Sunthakar, S. V. ..	Acylaminoanthraquinones and Anthrimides	Dr. K. Venkataraman	U. D. C. T.

BOOKS RECEIVED

Annual Report of the Indian Drugs Research Association, Poona, for the year 1947.

Investigations of the Band-Spectrum of Beryllium, Oxide by Albin Lagerqvist, Uppsala, 1948.

Publications of the Council for Scientific and Industrial Research, of the Commonwealth of Australia—

Annual Report ending 30th June 1948, Twenty-first.

Contributions to the Study of the Cell Wall, by A. B. Wardrop and H. E. Dads-well, Bulletin No. 221.

Frictional Properties of Lead-Base and Tin-Base Bearing Alloys, by D. Tabor, Bulletin No. 212.

Preparation and Properties of Aluminium Fluoride the—, by T. R. Scott, Bulletin No. 230.

Preparation and Properties of Synthetic Cryolite, the—, by D. Dixon and T. R. Scott, Bulletin No. 214.

Studies in Cement-Aggregate Reaction, Bulletin No. 229.

Sino-Swedish Expedition, the— Reports from the Scientific Expedition to the North-Western Provinces of China under the Leadership of Dr. Sven Hedin.

Theory of the Travelling—Wave Tube, the—, by O. E. H. Rydbeck. Reports from the Research Laboratory of Electronics, Chalmers, University of Technology, Gothenburg, Sweden.

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THE MUSCULAR SYSTEM OF UROMASTIX HARDWICKII GRAY

BY J. C. GEORGE,

Royal Institute of Science, Bombay

THERE is a general lack of literature on the muscular system of the reptiles. It was therefore considered advisable to work out the muscles of *Uromastix hardwickii* Gray as far as possible. The attempt, however, is made considerably difficult on account of the confusion in nomenclature. The terminology adopted in this paper is that of Romer modified in some cases by that of Appleton and Hyman.

The reptilian musculature is a great advance over that of fishes, to a lesser extent over that of amphibians and is very well near that of mammals. It is thus quite in the right direction on its journey towards the final form attained in evolution by the muscular system. The principal modification, namely, the splitting up of the intrinsic appendicular masses into separate individual muscles with a great concentration on the shoulder and hip girdles, is undoubtedly due to the greater development of the limbs associated with higher elevating effort above the ground and the need for a greater variety of movements as a consequence of the conquest of land. As regards the trunk muscles, the primitive segmental plan though still evident, the dorsal series are differentiated into longitudinal ones called the epaxial muscles responsible for the movements of the head and vertebral column and ribs, and the ventral ones into longitudinal and oblique muscles called the hypaxial muscles responsible for the movements of the ventral body wall.

THE MUSCLES OF THE HEAD (Fig. 1). The muscles of the head comprise those concerned with the movements of the mandibles, the floor of the mouth, and the eyes.

The *adductor mandibulae* is the chief muscle which brings about the adduction of the mandible towards the maxilla in the act of mastication. It arises from the jugal and is inserted on the ventro-lateral border of the mandible. It is a conspicuous muscle on the side of the head and it is easily identified from the obliquely downward and forward course of its fibres.

The *pterygoideus externus* is a large muscle concerned in the depression of the mandible. It arises from the lateral side of the squamosal and goes forwards and downwards; then it deflects itself towards the ventral side and there becomes tendinous. This tendon now joins the tendon of the *Pterygoideus internus* and is finally inserted on the proximal end of the Pterygoid on the roof of the mouth.

The *pterygoideus internus* arises from the lateral side of the mandible at its articulation with the quadrate. Its fibres proceed along with those of the *P. externus*, so much so that both these muscles appear as one. Its insertion has already been mentioned above.

The *depressor mandibulae* is the posterior-most muscle on the lateral side of the head. Its function is to depress the mandibles as indicated by the name. It arises from the posterior surface of the backward process of the parietal and from the postero-lateral corner of the skull where the squamosal, parietal process, the exterior arm of the exoccipital and the quadrate meet. Its course is vertically downwards and its insertion is on the articular process of the mandible.

The *temporalis* is a large block of muscle which fills the temporal cavity. It arises from the bones surrounding the supra-temporal fossa and it proceeds downwards and forwards to attach itself to the posterior face of the vertical portion of the transpalatine at its junction with the pterygoid.

The *inter-mandibularis* (mylohyoid) is a superficial muscle on the floor of the mouth which stretches across between the two halves of the lower jaw. Its function is to depress the floor of the mouth.

The *constrictor colli* (cervical constrictor) is a very long muscle in the long-necked reptiles, but in *Uromastix* it is short. It is a transverse muscle running superficially on the ventral side of the neck.

The upper muscles on the floor of the mouth consist of the hyoglossus, genioglossus and the geniohyoid. Behind these on the ventral surface lie the sternohyoid, and the omohyoid. The *hyoglossus* arises from the body of the hyoid and is inserted at the base of the tongue. The *genioglossus* arises from the chin and is inserted at the base of the tongue. The *geniohyoid* arises from the hyoid and is inserted on the chin. The *sternohyoid* arises from the dorsal surface of the sternum and coracoid and is inserted on the ventral surface of the hyoid. The *omohyoid* is a more lateral muscle which arises from the shoulder and is inserted on the hyoid.

THE MUSCLES OF THE TRUNK (Figs. 1 & 2). The muscles of the trunk consist of a dorsal epaxial group and a ventral hypaxial one. The epaxial muscles comprise the medial and lateral groups of longitudinal muscles. The medial group lies on either side of the neural spines of the vertebral column. The medial group consists of the inner spinalis and the outer semi-spinalis muscles. The lateral group is made up of the longissimus and the ilio-costalis muscles.

The *spinalis muscle* lies along the trunk very close to the neural spines, while the *semi-spinalis* is more lateral. But these two are so closely associated that they are often referred to as the spinalis-semi-spinalis system. The spinalis takes its origin by tendons from the neural spines and each component of the muscle is inserted on the neural arch of an anterior vertebra. The spinalis (like other longitudinal muscles, is divisible into *spinalis dorsi*, *s. cervicis* and *s. capitis* according to the position of the parts. The spinalis system by its contraction enables the lateral movement of the vertebral column.

The *semi-spinalis* takes its origin lateral to the insertion of the *spinalis*, that is from the neural arches and each component is inserted by tendon on the neural spine of an anterior vertebra.

The *spinalis* and *semi-spinalis* muscles run in a criss-cross manner. On account of this arrangement, when these muscles contract together, which they do, the lateral bending of the vertebral column which occurs as a result takes place in one plane. If they acted independently the movement would have been in two different planes.

Mention may be made here of the following short epaxial muscles in reptiles lying internal to the *spinalis* and *semi-spinalis* systems. (1) The *inter-spinalis* muscles which connect two successive neural spines. (2) The *inter-arcualis* muscles which run between two successive neural arches. (3) The *inter-articularis* muscles which attach two successive bases of the neural arches. (4) The *inter-transversi* which connect two successive transverse processes. In *Uromastix* the first three are present, but the last one is absent.

The *longissimus* lies medial to the *ilio-costalis* and lateral to the *semi-spinalis*. This muscle is also divisible into separate parts according to the location of the parts. It is segmentally divided by septa in *Sphenodon* (Nishi 1916) and crocodiles (Gadow 1882), but in *Uromastix* such septa do not exist. Like the other longitudinal muscles the *longissimus* also arises by a number of origins namely, from the ilium, sacrum, and the neural arches. Its insertions are on the anterior vertebrae on their neural arches. The anterior-most insertions, however, are on the skull at the junction between the parietal and the supra occipital. The contraction of this muscle brings about the elevation of parts of the vertebral column and also of the head. The *longissimus* is usually a large muscle in certain reptiles and mammals, but in *Uromastix* it is a much thinner strip. It may also be mentioned in this connection that in those animals having a well developed *longissimus*, the dorsal vertebrae bear well developed transverse processes from which they take their origins mostly. It is significant that in *Uromastix* the dorsal vertebrae do not show transverse processes.

The *ilio-costalis* lies ventro-lateral to the *longissimus*. It shows the segmental septa clearly unlike the *longissimus*. It takes its multiple origin from the ilium and the fascia of the *longissimus*. It is inserted on the anterior ribs. The anterior-most insertions, however, are on the atlas vertebra and the occipital region of the skull. On the flank the *ilio-costalis dorsi* meets the external oblique muscle of the abdomen. It seems to assist the *longissimus* in its action.

The cervical part of the trunk musculature other than those described above consists of a superficial lateral group of *costo-cervicals*, and a deeper group made up of a dorso-lateral *rectus capitis*, a lateral *obliquus capitis*, and a ventro-lateral *cervicis longus*. The *costo-cervicals* or scalenes of the epaxial system arise from the anterior-most thoracic ribs and are inserted on the anterior cervical ribs. The *rectus capitis* and the *obliquus capitis* which are known as the occipital group of muscles extend from the anterior cervical vertebrae to the atlas and the occipital region of the skull. The *costo-cervicals* and the occipital

group enable the lateral deflection of the neck and head. The *cervicis longus* arises from the lateral arm of the exoccipital and is inserted all along the ventral surfaces of the cervical ribs.

Among the trunk muscles, the hypaxial group consists of an oblique and a ventral series. The oblique series are made up of the external oblique, the internal oblique and the transversus. Lying deeper than these are the intercostals which also consist of external and internal oblique muscles. The ventral series are made up of the *rectus abdominis* on either side.

The fibres of the *external oblique* take their origin from the posterior two cervical ribs and the costal cartilages of the thoracic and lumbar ribs. Of these the anterior-most and the posterior-most few fibres run in a more or less antero-posterior direction and the intermediate ones in a postero-medial direction. The anterior-most fibres are inserted along the xiphisternal horns, the posterior-most ones on the pubes and the intermediate ones on the *linea alba* which is feebly developed in this animal. The function of this muscle is to constrict the abdominal wall which helps in the movement of the animal.

The *internal oblique* has its fibres arising from the ribs of the lumbar vertebrae and they run in an antero-medial direction. They are inserted on the *linea alba* and the xiphisternal horns. The action of this muscle is compression of the abdominal wall. The *transversus abdominis* also arises from the ribs of the dorsal vertebrae. Its fibres run in a more or less transverse direction and are inserted on the *linea alba*. This muscle is also a compressor of the abdominal wall.

The *intercostals* are short muscles connecting successive ribs. The fibres of the external intercostals run in a postero-medial direction. Those of the internal intercostals on the other hand run in an opposite direction, viz., antero-medial. Posteriorly in the abdominal region the external intercostal is represented by the *quadratus lumborum* which is inserted on the ilium. The intercostals are responsible for the respiratory movements of the ribs.

Mention may be made here of three minor series of muscles which belong to the hypaxial group. These are the subvertebral, subcostal and the *levator costarum*. The first runs transversely along the vertebral side. The second and third also run in a transverse manner on the ventral side of the rib, though the latter is deeper and median.

The ventral series of muscles comprise the *rectus abdominis* on either side of the *linea alba*. This muscle extends from the pubic symphysis to the xiphisternal horn. It is enclosed by the fascia of the internal and external oblique, and the transversus.

The posterior boundary of the external oblique in mammals like man is made up of a double fold of the fascia of the muscle itself. This structure which stretches between the anterior superior iliac spine and the pubic tubercle in men is called the inguinal ligament. It serves to separate the abdominal region from the thigh. In *Uromastix* the inguinal ligament though serves the same purpose has an attachment

different from that in man. It is attached in this animal on the public spine laterally and to the tip of the ischium medially. Moreover it gets merged with the ischio-pubic fascia at its medial attachment. Such a relation with the posterior fascia is absent in man.

In spite of the fact, that the muscles of the abdomen are well distributed and arranged, gaps are left in certain vertebrates including man, without a layer of muscle over the parietal peritoneum. Such a weak spot occurs in *Uromastix* on the lateral side of the abdomen more towards the inguinal region. This is a triangular space covered by fascia on the outside and if this fascia is removed carefully, the parietal peritoneum is exposed. The boundaries of the space are as follows. Dorsally it is flanked by the *quadratus lumborum*, antero-laterally by the posterior belly of the external oblique and posteriorly by the ilium and the muscles covering it.

THE MUSCLES OF THE TAIL (Figs. 1 & 3). On the dorsal side on either side of the neural spines in the tail is continued the feeble caudal part of the spinalis-semi-spinalis system. Lateral to the semi-spinalis lies a massive muscle arising from the posterior tip of the ilium. This muscle proceeds posteriorly gaining insertion on its way on the side of the neural arches of the vertebrae and terminates at the tip of the tail. This muscle known as the *ilio-caudalis* is a powerful abductor of the tail. The sudden abduction of the tail to one side causes a hard slash.

On the ventral side of the tail, that is below the level of the transverse processes of the caudal vertebrae, lies two pairs of large longitudinal muscle series. The inner series arises from the posterior spines of the ischia, while the outer has its origin on the ventral surface of the femurs, at the junction of their upper and middle thirds. Both these muscles are inserted all along the ventral surface of the caudal vertebrae. The inner series called *ischio-caudalis* and the outer known as *femero-caudalis* act in opposition to the *ilio-caudalis*. That means they are adductors.

On the lateral aspect of the tail segmentally arranged is a series of muscles which connect the transverse processes of the caudal vertebrae to the lateral wall. The insertion of these muscles is on the tips of the lateral transverse processes both above and below. These muscles are meant to render the tail a stiff organ.

THE MUSCLES OF THE SHOULDER GIRDLE AND FORELIMB (Fig. 1). The muscles causing the movement of fins in fishes consist of a dorsal mass which forms the abductor and a ventral mass which is the adductor. In the amphibians these masses of the pectoral fins have differentiated into a number of muscles from shoulder to limb and those of the different sections of the limbs. It has already been mentioned that the reptilian musculature is a further advance over that of the amphibians. For convenience sake the muscles of the shoulder girdle and those of the upper arm may be dealt with together, and those of the forearm separately.

The muscles of the shoulder and upper arm can be better described by dividing them into those on the postero-dorsal aspect and those on the antero-ventral side. When the skin on the dorsal side of the shoulder is

reflected the muscles that attach the shoulder to the trunk are exposed. They are from before backwards, the episterno-hyoid, *sterno-cleido-mastoid*, levator scapulae, trapezius, and latissimus dorsi. Of these the first two are on the entero-ventral side, while the others belong to the postero-dorsal groups. When the above muscles are reflected, the serratus muscle which lies deeper and connects the trunk to the shoulder, is brought into view. This muscle also belongs to the postero-dorsal group. Another deep muscle which connects the trunk to the shoulder is the sterno-coracoides which, however, belongs to the antero-ventral group. Of the postero-dorsal group, the remaining muscles are those of the upper arm. They consist of the deltoides which lies anterior and the anconeus which lies posterior.

The *levator scapulae* (Fig. 1) originates from the anterior border of the supra-scapula and proceeds forwards to be inserted on the postero-lateral corner of the skull. This muscle as its name indicates is an elevator of the scapula in man, but in *Uromastix* on account of its tetrapodan posture, it is a protractor of the shoulder.

The *trapezius* (Fig. 1) is a large triangular muscle arising from the dorsal fascia and is inserted on the acromio-clavicular joint. Its function is to elevate the shoulder slightly towards the medial plane.

The *latissimus dorsi* (Fig. 1) is the largest muscle on the dorsal side of the trunk, connecting the girdle to the body. It has a very much longer and wider origin than the trapezius. It is the powerful retractor of the shoulder. It arises like the trapezius from the dorsal fascia and is inserted on the medial surface of the upper end of the humerus.

The *serratus* (Fig. 6) in *Uromastix* consists of an anterior part inserted on the medial surface of the upper border of the supra-scapula and a posterior part inserted on the posterior border of the same cartilage. The serratus arises from the lateral surface of the last two cervical and first two thoracic ribs. The posterior, slightly longer and oblique part, inter-digitates with the external oblique muscle. The anterior which is directed upwards and medially is shorter and lies under cover of the supra-scapula unlike the posterior part. The function of the serratus is to keep the shoulder in position and to depress it.

The *deltoides* (Figs. 5 & 8) is a large muscle of the shoulder and upper arm consisting of two parts at origin. The more anterior of the two, the *deltoides clavicularis* and the other *d. scapularis* arise from the medial half of the clavicle, and the anterior and medial border of the outer surface of the supra-scapula respectively. These two parts join and finally terminate together on the deltoid ridge of the humerus. This muscle is a powerful abductor of the arm beyond 30°.

The *anconeus* (Fig. 6) is a large muscle lying on the posterior surface of the arm and is made up of four different parts at its origin. The first part which is the most conspicuous lies on the lower portion of the lateral side of the arm. The second lies immediately above. The third lies between the first and second parts below them and adjoining the humerus. The fourth lies medial to the third. The first arises from the deltoid ridge of the humerus, the second from the medial side of the scapula near

the glenoid cavity, the third from the medial side of the head of the humerus, and the last one from the posterior angle of the coracoid on its dorsal surface. The first three have a fleshy origin, while the last one is provided with a long thin tendon at its origin. These parts cover the humerus and after converging into a stout tendon terminate on the olecranon process of the ulna. From the position and arrangement of these four parts of the anconeus, it seems more than probable that the fourth part in the reptile represents the anconeus in man. The other three parts together form the triceps in mammals. This homology has been pointed out by Romer and others. It is partly an elevator of the arm and partly an extensor of the forearm.

The antero-ventral group comprise several muscles among which the episterno-hyoid, the sterno-cleido-mastoid and the sterno-coracoides have already been referred to. The other muscles of the antero-ventral group are several among which only the pectoralis is concerned in connecting the shoulder girdle to the trunk. The others are upper arm muscles.

The *episterno-hyoid* is a thin longitudinal muscle stretching from the episternum to the hyoid. Its contraction probably brings about the retraction of the hyoid.

The *sterno-cleido-mastoid* (Fig. 1) consists of a medial part arising from the sternum and a lateral larger part arising from the clavicle. This muscle is finally inserted on the postero-lateral corner of the skull. It is concerned in causing the bending of the neck downwards when both the right and left side muscles act together. When only one side muscle contracts it brings about a slight rotation of the head to that side.

The *pectoralis* (Figs. 4 & 8) is the largest breast muscle and it takes its origin from the inter-clavicular joint anteriorly, along the episternum and sternum in the ventro-median line and posteriorly along the xiphoid horns. From this broad origin the fibres converge towards the upper arm and is inserted on the deltoid ridge of the humerus. It is the chief adductor of the arm.

The *sterno-coracoides* arises from the dorsal surface of the sternum along its lateral border and it then proceeds forwards towards its insertion on the anterior part of the dorsal surface of the coracoid. The only function that can be ascribed to it is that it enables the sternum and coracoid to maintain their natural positional relation.

The *supra-coracoides* (Fig. 5) is partly covered by the deltoides and partly by the pectoralis. When these two muscles are reflected this muscle is brought into view. Its medial portion arises from the coracoid and a small portion of the scapula its lateral smaller portion, arises from the scapula. These two portions converge towards the insertion of the muscle on the deltoid ridge and the dorsal part of the neck of the humerus. This muscle corresponds to the supra-spinatus of mammals. It initiates the abduction movement of the upper arm upto about an angle of 30°.

The *sub-coraco-scapularis* (Fig. 6) is a fan-shaped muscle on the dorsal surface of the coracoid and scapula. The coracoid portion of the muscle

almost makes the whole bulk of it, while its scapular portion is insignificant. The former arises from the whole surface of the coracoid and the latter from the anterior end of the scapula by a tiny tendon. These two parts together proceed posteriorly and gain a fleshy insertion on the medial side of the head of the humerus. This muscle is an adductor of the arm.

The *scapulo-humeralis* (Figs. 6 & 7) is made up of two components namely a *scapulo-humeralis* anterior and a *scapulo-humeralis* posterior. The former arises from the lateral edge of the scapula on its ventral aspect and is inserted on the medial side of the head of the humerus. The latter arises from the medial part of the supra-scapula on its dorsal aspect and is inserted along with the former on head of the humerus. This muscle is also an adductor of the arm. The sub-coraco-scapularis and the *scapulo-humeralis* posterior together correspond to the sub-scapularis of the mammals. The *scapulo-humeralis* anterior is homologous with the *teres minor* and the *infra-spinatus* together of the mammals. It may be mentioned in this connection that *teres major* of the mammals is included in the *latissimus dorsi* in reptiles.

The *coraco-brachialis* (Figs. 6, 7 & 8) arises from the postero-medial angle on the ventral surface of the coracoid. After proceeding along the medial side of the arm it gains its insertion on the antero-medial surface of the lower end of the humerus. It is also an adductor of the arm. It is able to bring about also a slight protraction of the arm.

The *biceps* (Figs. 6, 7 & 8) as its name indicates has two heads. Of the two heads one is very much larger than the other and it arises from the coracoid slightly lateral to the origin of the *coraco-brachialis*. The other originates lateral to the first head mentioned above. This is the main muscle on the antero-ventral face of the arm. It proceeds towards its insertion on the medial surface of the upper end of the radius. It is a powerful flexor of the forearm. It is also a supinator of the forearm.

The *brachialis* (Figs. 7 & 8) lies dorso-lateral to the *biceps* and medial to the first part of the *anconeus*. It arises from the deltoid ridge of the humerus and passes very close to the shaft of that bone to be inserted along with the tendon of the *biceps*. It is an auxiliary flexor of the forearm.

The Muscles of the Forearm and Manus: Howell (1933-1937) has dealt with the primitive tetrapoden musculature of the forearm and its evolution through the various tetrapods. He has proposed that primitively there were three main masses of extensors, namely, *extensor humero-radialis*, *extensor humero-ulnaris* and *extensor humero-radialis*. Correspondingly the flexors were *flexor humero-radialis*, *flexor humero-ulnaris*, and *flexor humero-palmaris*. These have given rise in reptiles to the extensors—*brachio-radialis*, *extensor carpi radialis*, *extensor digitorum longus*, *extensor digitorum brevis* and *extensor carpi ulnaris* and the supinators from the dorsal group, and the flexors—*flexor carpi radialis*, *flexor digitorum sublimis*, *flexor digitorum profundus*, *flexor carpi ulnaris*, and the pronators from the ventral group.

The *extensor carpi ulnaris* (Fig. 9) arises from the posterior surface of the medial condyle of the humerus and proceeding to the forearm it covers the dorsum of the ulna. It is finally inserted on the carpus ulnare.

The *extensor digitorum communis* (Fig. 9) originates from the posterior surface of the lower end of the humerus. It lies more or less in the middle of the dorsum of the forearm and at the wrist it divides into five tendons, each of which is inserted at the base of the terminal phalanx of each digit.

The *extensor carpi radialis* (Fig. 9) arises slightly lateral to the origin of the abovementioned muscle and proceeding forwards in the forearm it is inserted on the carpus radiale.

The *brachio-radialis* (Fig. 6) is the anterior-most muscle on the dorsum of the forearm. It arises from the lateral condyle of the humerus on its posterior aspect and completely covers the radius as it proceeds towards its insertion on the distal of that bone. This is an extensor of the forearm.

The *extensor digitorum brevis* (Fig. 9) arises from the proximal row of carpals and soon after, it divides into five slips one for each digit. Each of these at the distal end of the metacarpal of the particular digit divides forming two tendons which proceed on either side of the digital bones. Finally these tendons are inserted at the base of the penultimate phalanx. The *extensor digitorum brevis* lies deeper than the *extensor digitorum longus* and its two tendons proceed on either side of the tendon of the latter. It is a shorter muscle than the *extensor digitorum longus* as the name indicates. It is an extensor of the digit excluding the last phalanx.

The *supinator manus* (Fig. 9) is the deepest muscle on the dorsum of the forearm. It arises from the posterior border of the ulna and is inserted on the posterior border of the distal half of the radius. It is the supinator of the forearm.

The *flexor carpi radialis* (Fig. 10) arises from the lateral epicondyle of the humerus and proceeds along the anterior border of the radius on the ventral side to be inserted at the base of the first metacarpal. It is a flexor of the wrist joint.

The *flexor digitorum sublimis* (Fig. 10) arises from the anterior surface of the distal end of the humerus and proceeds along the forearm to become a broad sheet on the palm. At the distal part of the palm it divides into five slips each of which gives rise to two thin tendons at the distal end of the metacarpals of each digit. These tendons proceed along the lateral sides of the digit and are inserted at the base of the penultimate joint.

The *flexor digitorum profundus* (Figs. 10 & 11) is a large deep flexor muscle of the digits. It consists of two muscles, one large and superficial arising from the medial condyle of the humerus and the other a smaller one arising from the ventral surface of the ulna. The latter part goes obliquely and joins the longitudinally-running former at the carpus.

They give rise to a single large tendon which is divided into five tendons going respectively to the five digits. Each of these tendons is thicker and stronger than any of the tendons of *flexor digitorum sublimis* and is inserted at the base of the terminal phalanx.

The *flexor carpi ulnaris* (Fig. 10) arises from the ventral surface of the proximal end of the ulna and proceeding along the posterior border of the forearm is inserted on the pisiform bone of the wrist.

The *pronator* (Fig. 12) is the deepest muscle on the flexor (ventral) side of the forearm. It arises from two sources, namely, the medial epicondyle of the humerus and the lateral border of the ulna. Both these origins converge towards the radius and gain an insertion on the medial surface and the postero-medial border of the lower two-thirds of the radius.

The *dorsal and palmar interossei* are the deepest muscles on the dorsal and palmar surfaces of the manus. Their situation is inter-metacarpal. The dorsal ones are abductors, while the ventral ones are adductors of the digits, the middle digit being considered as the central axis.

THE MUSCLES OF THE PELVIC GIRDLE AND HIND LIMBS. The pelvic musculature can be divided into long muscles which extend from the girdle to the shank and short muscles which extend from the girdle to the femur. On the dorsal aspect the long extensor muscles consist of a large mass, the *triceps femoris* divisible into ilio-tibialis, femoro-tibialis anterior and femoro-tibialis posterior, and a smaller mass attached to the fibula forming the ilio-fibularis. The short extensor muscles comprise the pubo-ischio-femoralis internus, the ilio-femoralis and the puboischio-femoralis posterior. On the ventral side there is a series of long flexors from the pubis and ischium to the tibia or shank fascia; these are the pubo-ischio-tibialis, semi-membranosus, biceps femoris, and semi-tendinosus. The short flexors which are deeply situated are really adductors. The chief among the adductors are the pubo-ischiofemoralis externus, adductor longus, adductor magnus, and adductor brevis.

The shank musculature consists of an extensor series on the outer or dorsal side and a flexor series on the inner side. The extensors are three groups, one on the fibular side, another on the middle side and a third on the tibial side. The flexor muscles are in three layers, an outer, middle and inner.

The *triceps femoris* (Figs. 13 & 14) is a large extensor mass consisting of three individual muscles. It has its origin in three sources, *viz.*, from the iliac spine and the lateral border of the iliac crest, from the lower third of the femur on the anterior side, and from the distal half of the femur on the posterior side. These three muscles which form a common muscle have a single insertion by means of a strong tendon on the patella and the dorsal tubercle of the tibia.

The *ilio-fibularis* (Figs. 13 & 15) is the posterior-most muscle on the dorsal side. It arises from the posterior part of the ilium and is inserted on the neck of the fibula. It is an extensor at the knee joint.

The *ambiens* (Figs. 13 & 14) is a large muscle with a massive belly arising by a tough tendon from the pubis near the ilio-pubic symphysis. The muscle closely adheres to the dorsum of the femur, but does not gain an attachment. It is inserted on the patella and the dorsal tubercle of the tibia through the common tendon of the triceps femoris. The *ambiens* is a muscle peculiar to the reptiles, and is supposed to be the *sartorius* of the mammals. It is an extensor of the leg.

The *pubo-ischio-femoralis internus* (Figs. 13, 16 & 19) corresponds to the *iliacus*, *psoas* and *pectineus* group of muscles of the mammals. It arises from the dorsal side of the pubis and ischium covering the obturator foramen of the pelvis, and is inserted on the dorsal surface of the proximal end of the femur.

The *ilio-femoralis* (Figs. 13B & 17) corresponds to the gluteal muscles of the mammals. It arises from the crest and body of the ilium below the origin of the *ilio-tibialis* and in front of the origin of the *ilio-fibularis*. It is inserted on the *linea aspera* of the femur on its proximal third. It is an abductor and a slight retractor of the thigh.

The *pubo-ischio-femoralis posterior* (Figs. 16 & 19) corresponds to the *obturator internus* of man. It arises from the dorsal surface of the ischium and pubis and is inserted on the dorsal surface of the proximal end of the femur. This muscle is an extensor of the thigh.

The *quadratus femoris* (Figs. 20) though not included in the list given above may also be mentioned here among the short extensors. It is a deep lying muscle arising from the tip of the ilium and inserted on the dorsal and anterior side of the femur at the junction of its upper and middle third. It is also a slight retractor of the thigh in addition to being a short extensor of the same part.

The *pubo-ischio-tibialis* (Figs. 13, 21 & 22) is the largest muscle on the ventral side and is triangular in shape. If a line be drawn from the tip of the pubic spine to the anterior tip of the ischium, that line would denote the base of the triangle. The apex of the triangle would be at its insertion on the proximal end of the tibia. This muscle takes its origin from the pubic spine, the ischio-pubic fascia and the anterior part of the ischium. Its insertion is by means of a broad and thin tendon on the medial and the anterior side of the head of the tibia. It is a powerful flexor of the knee and a slight adductor of the thigh.

The *semimembranosus*, *biceps femoris*, and *semi tendinosus* (Fig. 22) are the hamstring group of muscles on the postero-ventral aspect of the thigh. The former two muscles have a fascial origin from the posterior ischial spine, while the last one has a *tendinosus* origin from the posterior tip of the ilium. All the three are inserted on the medial condyle of the femur and the proximal end of the tibia. These are flexors of the knee.

The *pubo-ischio-femoralis externus* (Figs. 18, 21 & 22) is a fan-shaped muscle on the ventral side of the pelvis and it corresponds to the *obturator externus* of man. It arises from the ventral surface of the pubis and ischium and is inserted by a tough tendon on the trochanter of the femur. It is an adductor of the thigh.

The *adductor longus* (Figs. 22 & 23) arises by two slips, one, more massive than the other arising from the base of the pubic spine and the other originating laterally from the pubis. The two slips very soon adhere together into a single mass and take an oblique course towards the medial side of the knee. It is inserted on the posterior side of the lateral condyle of the femur. It is an adductor of the thigh.

The *adductor magnus* (Figs. 22, 23 & 24) is a large muscle having a fascial and a bony origin. It arises from the ischio-pubic fascia and the ischium. It covers almost the whole of the ischium and gains a fleshy insertion on the lower third of the femur on its medial side. It is also an adductor of the thigh.

The *adductor brevis* (Figs. 22 & 23) arises from a strong strip of fascia attached to the posterior spine of the ischium. Its insertion is on the antero-medial side of the lower end of the femur. It is like its two associates an adductor of the thigh.

Mention may be made here of a muscle arising from the posterior spine of the ischium and inserted on the hypo-ischial cartilage in the medial plane and the skin bordering the anus. I am at a loss to find the homologue of this muscle in other animals and therefore hesitate to name it. Its function seems to be to suspend the anus.

The *tibialis anticus* (Fig. 25) is a muscle which almost covers the whole of the anterior side of the shank. It has an extensive origin from the proximal end and the lateral surface of the tibia. Near the lateral malleolus the muscle tapers to a flat tendon. A very thin slip is split off from this main tendon and is inserted on the distal end of the first metatarsal bone. The large main tendon on the other hand is inserted at the base of the first metatarsus. It is an extensor of the foot.

The *extensor digitorum communis* (Fig. 26) is lateral to the *tibialis anticus* and it arises as a small thin tendon from the lateral side of the posterior condyle of the femur. It has a long fleshy belly which is lodged in between the tibia and fibula. Towards its insertion on the dorsum of the foot the muscle tapers into two tendons which are inserted at the base of the second and third metatarsal bones. It is an extensor of the foot.

The *peroneus* (Fig. 27) is an extensor of the foot lying lateral to the *extensor digitorum communis*. It arises from the head and the lateral surface of the shaft of the fibula. It is inserted on the posterior surface of the dorsum of the fifth metatarsal bone.

The *soleus* (Fig. 28) is a muscle with a large massive belly and lies posterior to the *peroneus*. It arises mainly from the head of the fibula and by a thin tendon from the posterior condyle of the femur. It has a double insertion, one on the posterior part of the composite large tarsal bone by a flat tendon and the other by a thin tendon which passes superficial to the tendon of the *peroneus* to be inserted on the posterior surface of the dorsum of the fifth metatarsal bone. This is a flexor of the foot.

The *plantaris* and the *flexor digiti quinti* (Fig. 29). The former is distinguished by its long tendon and it arises from the posterior surface of the posterior condyle of the femur in two small muscle bellies. It soon becomes tendinous and traverses a long distance to gain its insertion. The tendon of the *flexor digiti quinti* joins that of the *plantaris* proximally in the shank. The combined tendon is inserted at the base of the distal phalanx of the fifth digit. The *flexor digiti quinti* arises from the posterior border and a little portion of the lateral surface of the fibula and soon acquires a tendon which as mentioned above joins that of the *plantaris*. The *plantaris* is a degenerate muscle in man and it has nothing to do with the f. d. quinti (minimi) and is inserted on the calcaneum or sometimes it blends with the planter fascia. It is therefore probable that the *plantaris* of man might have undergone reduction as a result of the development of a powerful and independent f. d. minimi.

The *gastrocnemius* (Fig. 30) is the largest muscle in the shank. It arises by two heads, an anterior small one from the medial side of the anterior condyle of the femur and the other, a posterior large one, from the posterior condyle of the femur. The two heads converge forming a large belly which lies between the tibia and fibula. Further down it acquires a strong tendon which is inserted on the proximal end of the large proximal tarsus and the ventral surface of the fifth metatarsus. From the insertion of the *gastrocnemius* starts the planter aponeurosis. This muscle is a flexor of the foot.

The *tibialis posticus* (Fig. 31) arises from the distal half of the fibula and the distal fifth of the tibia. It is inserted on the medial surface of the proximal tarsus. It is a flexor of the foot.

The *flexor digitorum longus* (Fig. 32) arises from the interosseus border of the fibula from the region of its head and the proximal third of its shaft. The long fleshy belly of the muscle tapers to a strong tendon which becomes flattened out on the planter surface. The flattened portion is then divided into four parts, each of which goes to the first four digits. These tendons are inserted at the base of the distal phalanges.

The *abductor hallucis* (Fig. 31) is a very tiny muscle arising from the antero-medial surface of the distal third of the tibia. It is inserted at the base of the terminal phalanx of the first digit.

The *popliteus* (Fig. 32) is a deep triangular muscle of the shank arising by a tough tendon from the articular portion of the head of the fibula. It is inserted on the popliteal line on the medial surface of the proximal part of the tibia.

The *flexor digitorum brevis* (Fig. 33) consists of five separate slips one going to each digit in regular order. The slip for the first digit arises from the anterior part of the proximal tarsus those for the third, fourth and fifth digits from the fifth metatarsus and that for the second from the fifth metatarsus and the proximal tarsus. At the distal end of the respective metatarsal bones these muscle slips give rise to two thin tendons and they proceed distally and are inserted at the base of the penultimate

phalanx of each digit. The thick tendon of the flexor digitorum longus passes in between the two thin tendons of each slip of the flexor digitorum brevis.

The *plantar interosseus* (Fig. 34) forms the deepest group of muscles on the plantar surface of the foot. First this arises as a single tiny mass from the antero-medial part of the fifth metatarsus and gives off five different slips which are inserted at the distal end of the metatarsus of the respective digits. The contraction of the muscle slips causes a posterior deflection of the digits affected.

The *extensor hallucis* (Fig. 35) arises from the distal end of the tibia and is drawn into a long tendon which is inserted at the distal end of the first metatarsus.

The *extensor digitorum brevis* (Fig. 35) arises from the dorsal surface of the large proximal tarsus and proceeds forwards in five separate muscle slips which are inserted by two tendons on the dorsum of the proximal phalanx.

Mention may be made of a small slip of muscle arising from the distal end of the proximal tarsus to supply the fourth digit with an abductor tendon. Another muscle which lies in the deepest layer of the dorsum of the foot is the *dorsal interosseus* (Fig. 35) which consists of five separate slips. Each slip arises from the distal end of the proximal tarsus separately and is inserted at the distal end of the metatarsal concerned. The action of the dorsal interosseus is opposite that of the plantar one.

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I wish to record here my gratitude and indebtedness to Dr. C. J. George for various suggestions and criticisms offered by him during the course of the investigations.

BIBLIOGRAPHY

1. Adams L.A. . . A memoir on the phylogeny of the jaw muscles in recent and fossil vertebrates. Ann. N. Y. Acad. Sci. 28. 1919.
2. Adams L.A. . . An Introduction to vertebrates. 1934.
3. Appleton A.B. . . The muscles and nerves of the post-axial region of the tetrapod thigh. Jour. of anat. 62. 1928.
4. Brock. G.T. . . The cranial muscles of the Gecko. Proc. Zool. Soc. 108 B. 1938.
5. Byerly T.G. . . The myology of Sphenodon. Uni. Iowa. Stud. Nat. Hist. 11. 1926.
6. Camp. C.L. . . The classification of lizards. Bull. Amer. Mus. Nat. Hist. 48. 1923.
7. Cunningham . . . Manual of practical anatomy.
8. Eaton T.H. . . On the myology of salamanders with particular reference to Dicamptoden. Jour. Morph. 1936.

9. Edgworth. F.H. The cranial musculature of vertebrates. S. 1935.
10. Gadow H. . . Beitrage zur Myologie der Hinteren Extremitaten der Reptilian. Morph. Jahrb. 1882.
11. Gregory W.K. . . Studies in comparative myology and osteology Bull. Amer. and Camp. C.L. Mus. Nat. Hist. 38. 1918.
12. Greene E.C. . . Anatomy of the rat. Philadelphia. 1935.
13. Haines R.W. . . Some muscular changes in the tail and thigh of reptiles and mammals. Jour. Morph. 58. 1935.
14. ————— A revision of the extensor muscles of the forearm in tetrapods. Jour. Anat. 73. 1939.
15. Holmgren J. . . On the origin of tetrapodan limb. Acta. zur. Zool. 14. 1933.
16. ————— Contribution to the question of the origin of tetrapodan limb. *ibid.* 20. 1939.
17. Howell A.B. . . The primitive carpus. Jour. Morph. 57. 1935.
18. ————— The architecture of the pectoral appendage of the dogfish *ibid.* 54. 1933.
19. ————— The phylogeny of the distal musculature of the pectoral appendage. *ibid.* 60. 1936.
20. ————— The phylogenetic arrangement of the muscular system. Anat. Record. 66. 1936.
21. ————— Morphogenesis of the shoulder architecture. Auk. 54. 1937.
22. Hyman L.H. . . Comparative vertebrate anatomy. 1942.
23. Moy-Thomas J. A. Evolution of the pectoral fins of fishes and the tetrapodan forelimb. 1936.
24. Nishi S... . . Zur Ver Gleichenden Anatomie der eigentlichen Muskelen Morph. Jahrb. 1916.
25. Olson E.C. . . The dorsal axial musculature of certain primitive permean tetrapods. Jour. Morph. 59. 1936.
26. Romer A.S. . . The locomotor apparatus of certain primitive and mammal-like reptiles. Bull. Amer. Mus. Nat. Hist. 1922.
27. ————— Crocodilian pelvic muscles and their avian and reptilian homologues. *ibid.* 1923.
28. ————— Pectoral limb musculature and shoulder girdle structure in fish and tetrapods. Anat. Recod. 27. 1924.
29. Shann E.W. . . The comparative myology of the shoulder girdle and pectoral fin of fishes. Trans. Edin. Roy. Soc. 52. 1920.
30. Smith Malcolm. . Fauna of British India. Reptiles. 1945.

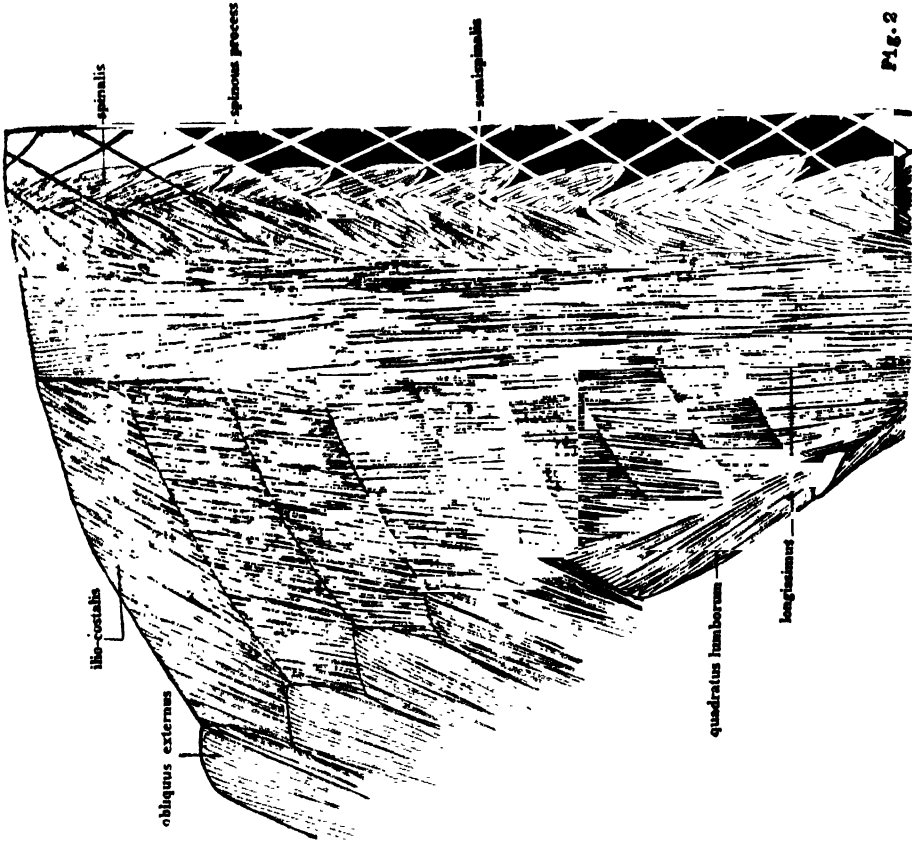


Fig. 2

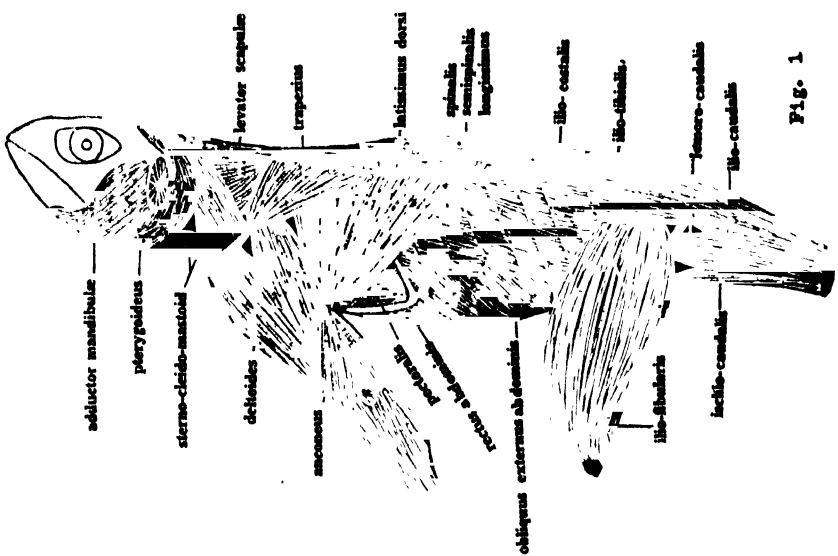


Fig. 1

Fig. 1. The muscles in lateral view.

„ 2. The apaxial musculature.

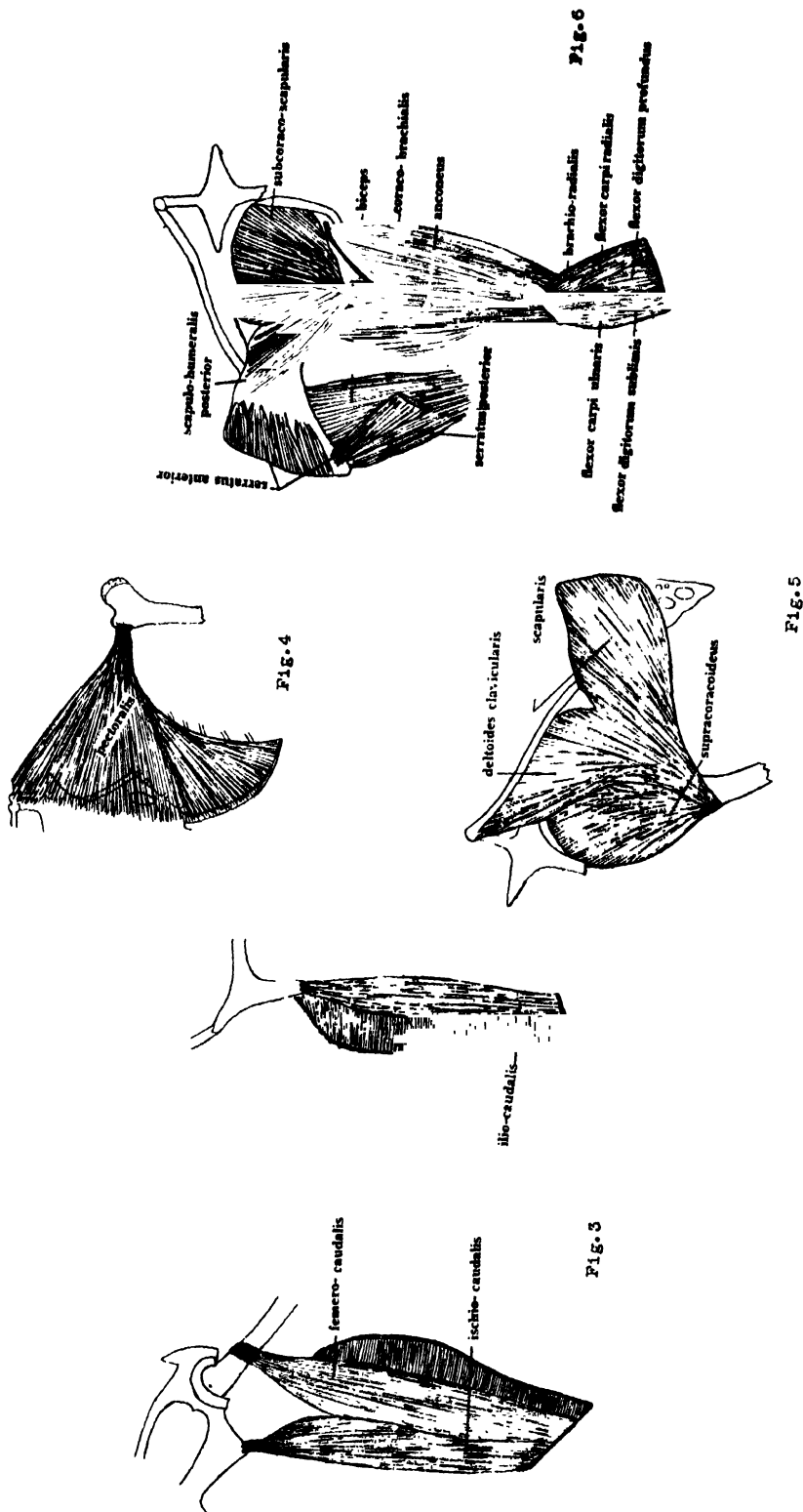


Fig. 3. The tail muscles. Fig. 4. The pectoralis muscle.
 „ 5. The deltoides and supra coracoides.
 „ 6. The shoulder and arm muscles in medial view.

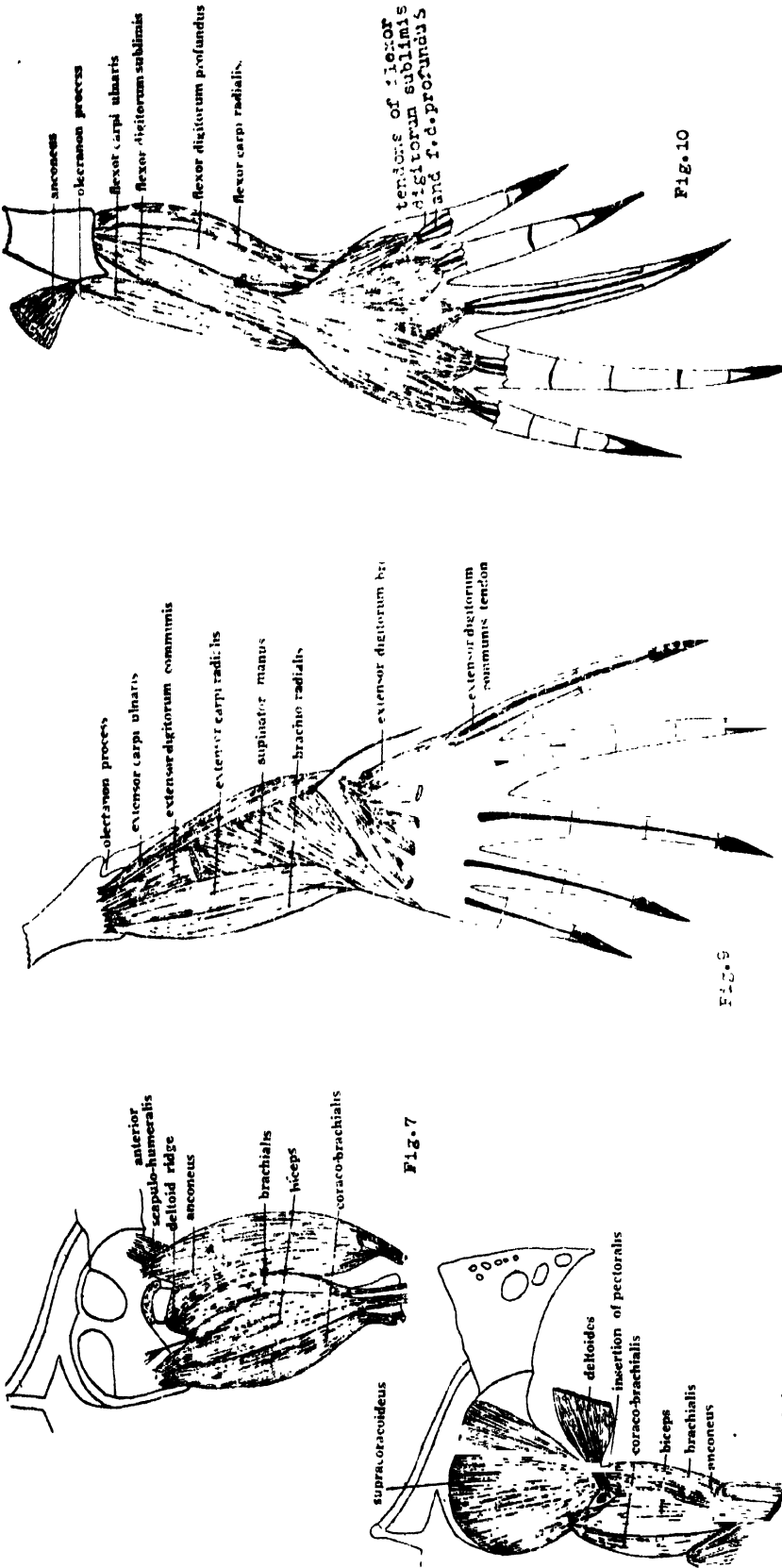


Fig. 7. The muscles of the upper arm in antero-lateral view.
 „ 8. The muscles of the shoulder and upper arm in anterior view.
 Fig. 9. The dorsal muscles of the forearm and hand. Fig. 10. The ventral muscles of the forearm and hand.

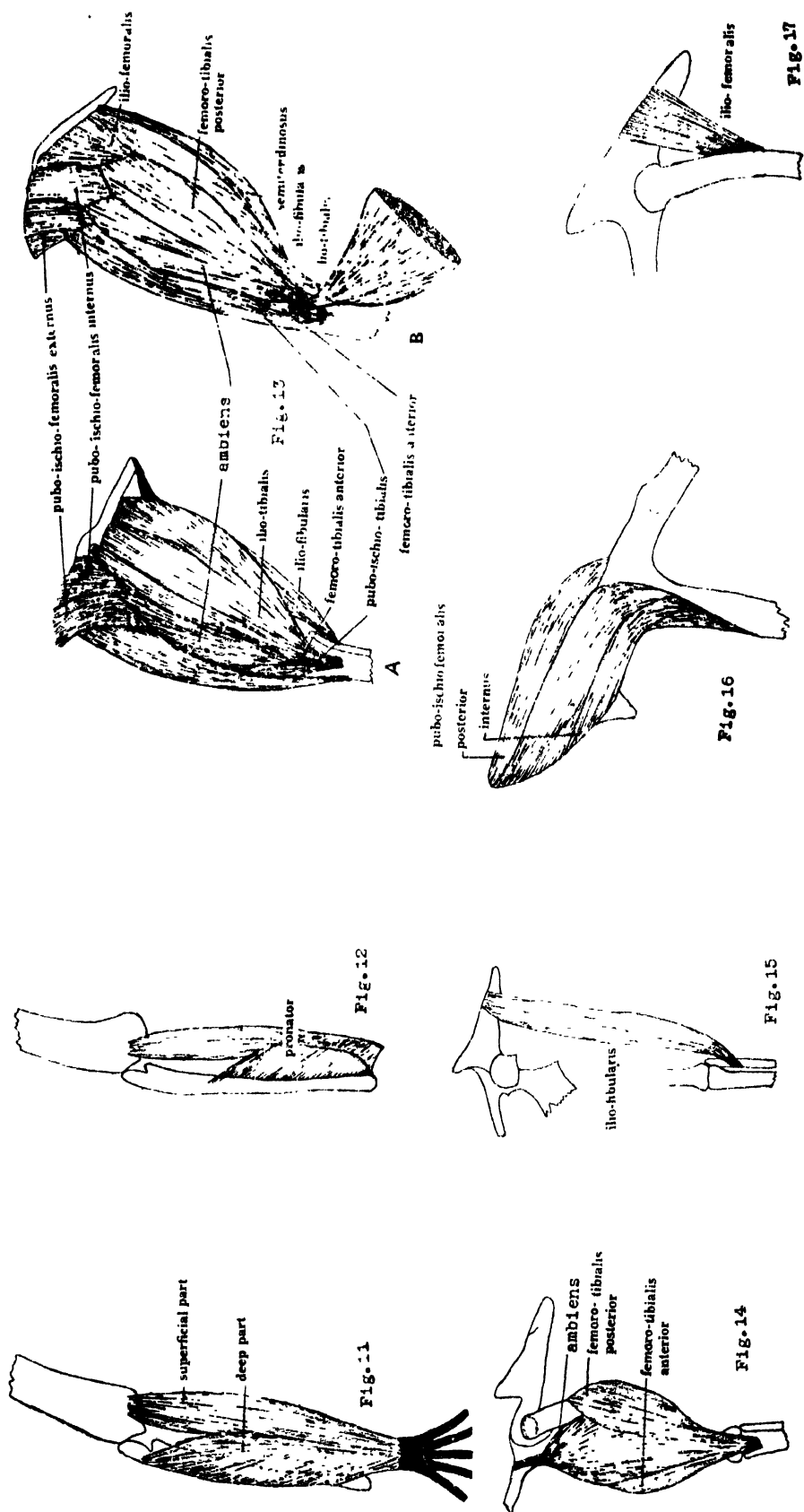


Fig. 11. The flexor digitorum profundus. Fig. 12. The pronator. Fig. 13. A. The dorsal thigh muscles in surface view. B. The same after reflection of ilio-tibialis. Fig. 14. The femero-tibialis anterior and f.t. posterior. Fig. 15. The ilio-fibularis. Fig. 16. The front view of pubo-ischio-femoralis posterior and p.i.f. internus. Fig. 17. The ilio-femoralis.

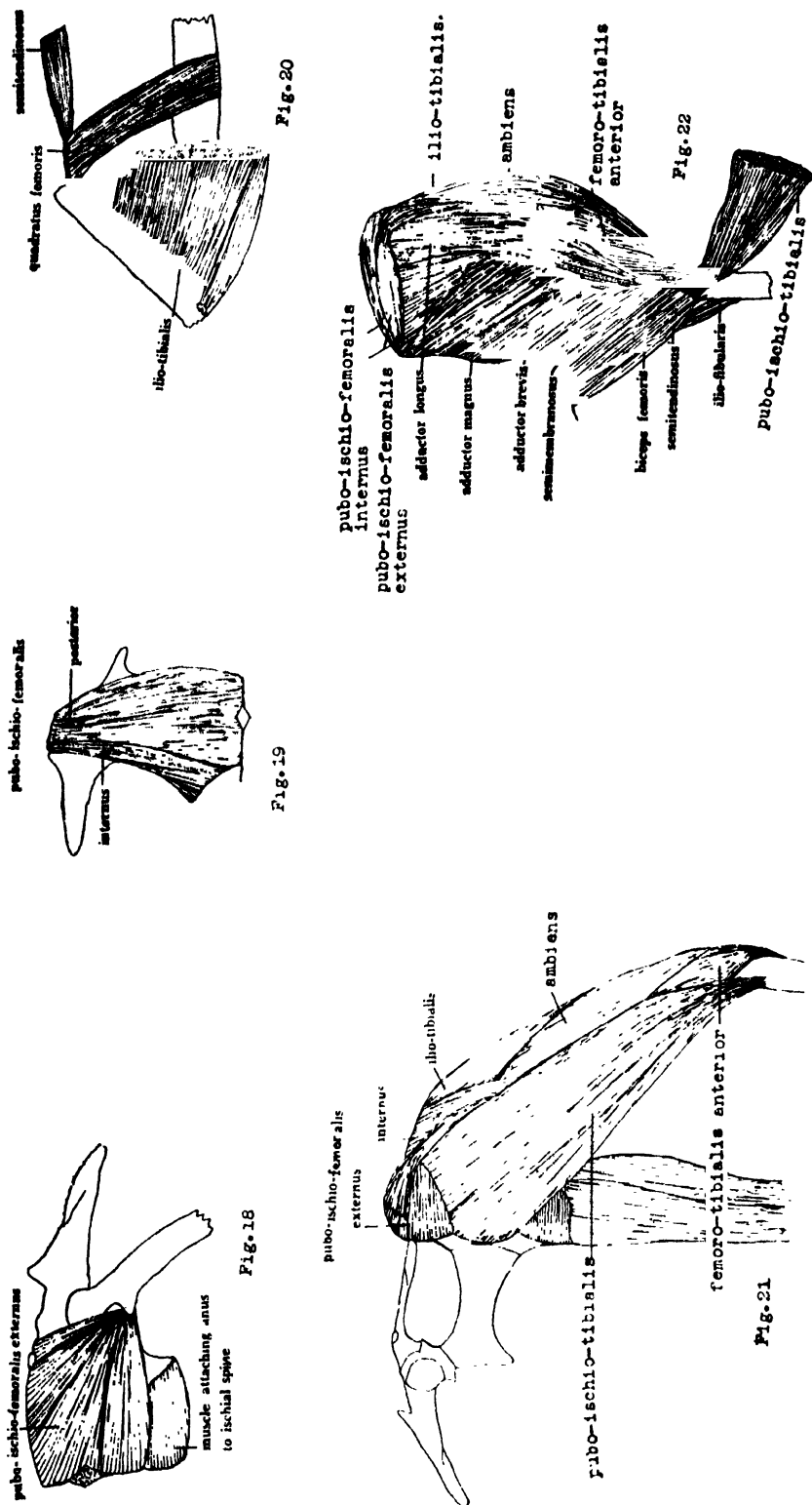


Fig. 18. The pubo-ischio-femoralis externus. Fig. 19. The pubo-ischio-femorals posterior.
 Fig. 20. The quadratus femoris. Fig. 21. The muscles of the thigh in ventral view.
 Fig. 22. The muscles of the thigh after reflection of pubo ischio-tibialis.

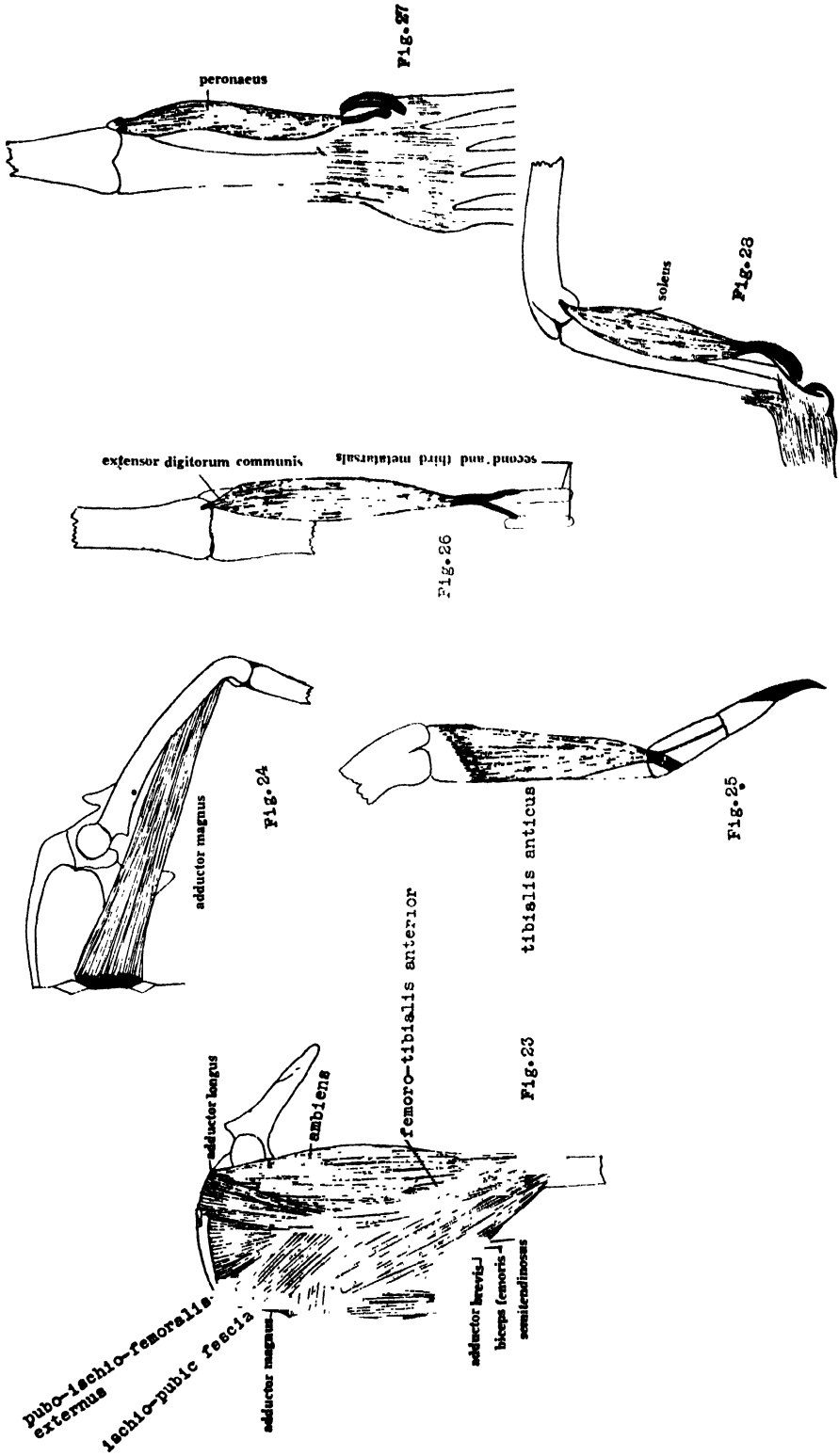


Fig. 23. The relations of adductor longus, adductor brevis and adductor magnus. Fig. 24. The adductor magnus. Fig. 25. The tibialis anticus. Fig. 26. The extensor digitorum communis. Fig. 27. The peronaeus. Fig. 28. The soleus.

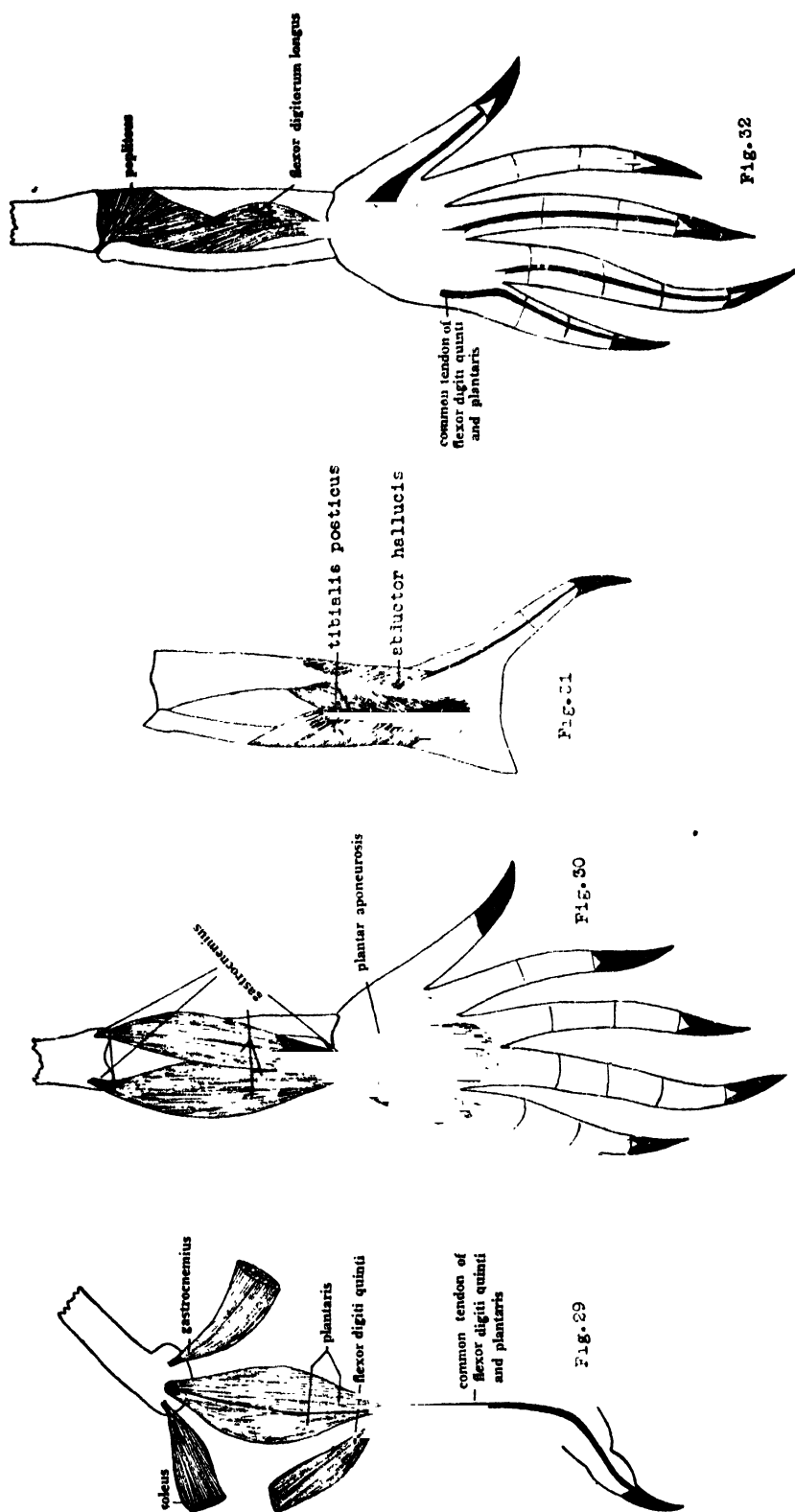


Fig. 29. The flexor digiti quinti and the plantaris. Fig. 30. The gastrocnemius.
 Fig. 31. The tibialis posterior and abductor hallucis.
 „ 32. The popliteus and the flexor digitorum longus.

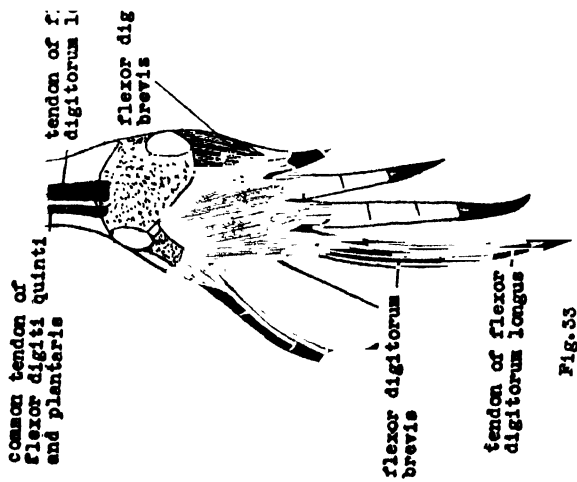


Fig. 33. The plantar muscles.
,, 34. The interossei plantares.
,, 35. The dorsal muscles of the foot.

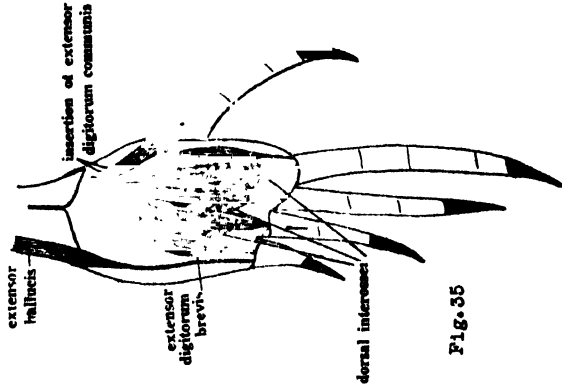
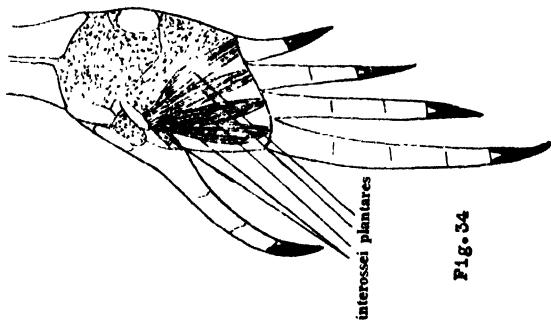


Fig. 33. The plantar muscles.
,, 34. The interossei plantares.
,, 35. The dorsal muscles of the foot.

STUDIES ON THE SUITABILITY OF SUGAR-CANE JUICE FOR THE GROWTH AND DISTRIBUTION OF SOME INTESTINAL PATHOGENIC BACTERIA

BY J. V. BHAT AND RODA REPORTER

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THAT the diseases of the intestinal tract, *viz.*, Typhoid, Paratyphoid, Dysentery, Cholera and Food-Poisoning get transmitted through the agencies of food, finger and flies is too well known to need any special reference here. More recent investigations have pointed out that in a majority of these infections or epidemics the carriers are responsible for their outbreaks and that it is they who really constitute a stumbling block which prevents the complete eradication of these diseases. Many workers are now laying more emphasis on the significance of basic sanitary measures for the control of these infections than on a general attempt at prevention by immunization alone : And the general opinion appears to be that the best preventive work is based on study of all possible causes of these outbreaks during periods free from epidemics.

Our observation in the City of Bombay and some other towns in the Presidency have pointed out the possibility of some of these intestinal infections spreading through certain foods and drinks not yet investigated by other workers. It is also undeniable that certain foods are more likely to carry virulent species than others and it is reasonable to suppose that some foods allow better growth and longer viability of the pathogenic bacteria than others. It is well known that sugar-cane juice is a very popular drink in some towns of this Presidency, more specially in Bombay, Poona, Sholapur, Pandharpur and Nasik. In Bombay and Poona this drink is of perennial popularity and more particularly in the warmer months—the months during or after which we encounter outbreaks of Typhoid as well as the flies. Pandharpur and Nasik have almost become notorious for some of these infections especially after the conclusion of some of the annual festivals during which thousands of unwary pilgrims consume large quantities of this and other drinks and foods catered for them in the most unhygienic way as possible. Even in Bombay (it is evident from the location itself of some of these stalls and the manner in which the canes are prepared and extracted) this drink is sold to the public in a very shabby way and more often than not the vendors who sell this drink come from the lowermost strata of society, illiterate, dirty, shabbily clad and as such it will not be a surprise if it is found that most of these people discharge the faecal organisms on whatever material they chance to handle. The observations of Buice *et al.* (1927) indicating that 8·38%

of cases (out of 337 tests made) examined by them had *E. coli* on the fingers is enough to convince any one of the danger that lurks in the contamination of foods and drinks through this origin. With a view therefore to see if cane juice can serve as a suitable vehicle for the transmission of these infections, the growth and viability of *E. typhosa*, *S. paratyphi*, *S. schottmuelleri*, *S. enteritidis*, *S. dysenteriae* (Shiga), *S. paradysenteriae* (Flexner), *E. coli communis* and *V. cholerae* in the juice were studied.

A short note announcing the salient features of the results obtained has already been published elsewhere (1948). In this paper it is proposed to report on every phase of the problem worked out in this connection including the chemical nature of the substratum. The chemical analysis of several samples of the juice collected specially for these studies has yielded the following average results: Moisture 75.14%; total sugars, including the 1.16% of the fermentable monosaccharide, 13.60%; total proteins 0.24%; the other constituents which make up the remaining are pectins, lignins, crude cellulose, amides, aminoacids, gums and ash elements. All these ingredients promise to make the juice a suitable substratum for the growth of bacteria, particularly after the juice has been diluted and which indeed is deliberately diluted by the vendors to make greater profits. Above all the juice has a favourable reaction, which is usually observed to vary from pH 6.8-7.0.

The microbiological examination of the juice revealed that the normal flora consists of sporulating aerobic bacilli, all Gram-positive species: *B. cohaerens*, *B. rufescens*, a starch hydrolysing variant of *B. mesentericus*, *Micrococcus perflavus* and an unidentified *Saccharomyces*. The essentially Gram-positive character of the above flora enabled us to study conveniently the fate of the different Gram-negative test organisms even in the non-sterilized samples of the juice. All the test bacteria, with the exception of *S. enteritidis* (kindly supplied by the Director of the Central Institute, Kasauli) and *V. cholerae* (Strain No. 67 and kindly supplied by Dr. R. G. Dhayagude of G. S. Medical College, Bombay), were isolated from Bombay itself for obvious reasons. The *E. coli communis* strain employed was the one isolated in this laboratory from a case of grapes-poisoning (1945) previously reported in this Journal. Sugar-cane juice was locally obtained from a vendor and it was always collected under carefully standardised conditions.

A number of preliminary studies with the undiluted, 50% diluted, unfiltered, muslin-filtered, steam-sterilized and filter-sterilized samples were made: during these studies, methods essential for determining viability, multiplication, virulence and pathogenecity were also standardised. Sugar-cane juice for the experimental studies was used in six different dilutions, viz., 1:32 (3.1% solution), 1:16 (6.1%), 1:8 (12.1%), 1:4 (25%), 1:2 (50% solution), and in the undiluted state. These dilutions were employed in their non-sterile, filter-sterilized and also steam-sterilized states. All the samples so obtained were seeded in test tubes (in 5 ml. quantities) with 0.1 ml. saline suspensions (matching approximately to Opacity Tube No. 4) of 24-hr. growths of the selected bacterial species and incubated at the room temperature (28°C) after 0.1 ml. portion from each tube was removed for the quantitative estimations of the inoculated bacteria. Further 0.1 ml. portions removed from each tube at regular intervals of time were also utilized for counting

the bacteria by the methods worked out for the purpose (1944) in this laboratory. Special media such as MacConkey's agar, Wilson and Blair's agar, Leifson's desoxycholate citrate agar and Aronson's agar were utilized for the quantitative studies, and peptone water, nutrient broth and MacConkey's broth were utilized for testing the viability. The morphological, staining, biochemical (carbohydrates and other reactions) and antigenic variations occurring in the bacteria were also followed by adopting suitable techniques. The results obtained indicate that multiplication and maximal survival periods for these bacteria vary not only from species to species, but also with regard to the dilution effected in the juice, the sterility status of the juice and other factors. It should also be mentioned here that the death of the organisms is clearly attributable to a drop in pH, which differs somewhat with the species and also according to the dilution and the sterility status of the juice. The formation of the acids in the juice is attributable to the fermentation activity of the bacteria on the fermentable carbohydrates, and, it is evident that in the non-sterile samples of the juice the indigenous flora have also a part to play in the changes brought about in the metabolites. It is also obvious that the fermentable monosaccharide is diminished in quantity as the dilution is effected and it is no surprise therefore to see the drop in pH being more gradual in the diluted samples of the juice as compared with the more concentrated. The following table gives some interesting data on the above point. The cane juice used in these experiments was the steam-sterilized sample (to obviate complexity in the interpretation of the results) and the results of the *Salmonella* and the *Escherichia* species are not included herein for the simple reason that they closely follow those of the *Eberthella* species. *V. cholerae* does not live long enough in the juice to be included in these studies.

TABLE 1

Dilutions of the cane juice	pH Values			
	Before Inoculation	24 Hrs. after Inoculation		
		<i>E. typhosa</i>	<i>S. dysenteriae</i>	<i>S. paratyphenteriae</i>
12½%	7.0	4.8	5.8	5.8
25%	6.8—7.0	4.8	5.0—5.2	5.0—5.2
50%	6.8	4.4	5.0	5.0—5.2
100%	6.8	4.4	4.8—5.0	5.0—5.2

From the above table we clearly see that within 24 hours a considerable amount of acid is produced by all the three organisms and that the H ion concentration is greater in the more concentrated samples of the juice than in the diluted samples. A drop from 6.8 to 4.4 is reached in a short time in the 50% and the 100% samples of the juice so much so that the more rapid disappearance of the bacilli from these tubes has to be explained on this basis alone as has been done previously by Mackenzie (1930). More experiments conducted on these lines have all indicated that these bacteria disappear quicker from those samples where the

lowermost pH is reached first than from other samples where the critical pH is reached more slowly.

Coming now to the actual results obtained with these test bacteria in the different samples of the juice :

E. Typhosa.—The results of the two filter-sterilized samples (bacteria-proof filtration through the Seitz could be achieved only in the two highest diluted samples) indicate that this bacterium can multiply and live well for about 1 day ; thereafter the cells begin to dwindle in numbers but continue to give viability results positive till the end of the 4th day. Throughout this period the bacterium continues to show its normal morphological and other characteristics. Occasionally, however, a slight morphological change (in shape only) is exhibited. Its Gram reaction remains unchanged.

In the steam-sterilized samples, on the other hand, it can live only for 1 day in the more concentrated samples, and a little less than 4 days in the highest two dilutions. Motility is impaired after 24 hrs in all the dilutions ; multiplication phase is exhibited only during the first 24 hrs, and with the appearance of the acids in the lower dilutions specially results in the disappearance of the organism at a more rapid rate. In fact, whereas the organism can live for only three days in the lower four dilutions of the juice, in the higher two dilutions it can survive for a longer period, *viz.* four days. One very interesting observation made in this connection is that *E. typhosa* not only loses its motility in the heat-sterilized samples of the juice but that it also develops a slight saccharose-fermenting activity. Moreover the loss in motility occurring in the juice is curiously regained on subculture in the peptone water or nutrient broth.

In the raw samples (unheated) this organism lives for full six days in all the dilutions of the juice. Multiplication of the organism in the juice is observable within 3-6 hrs of inoculation, but immediately thereafter the retarding influence of the acids produced begins to show itself. Nevertheless it may be concluded that in the two highest dilutions the bacterium lives without any sign of its losing its identity. In the lower dilutions, on the other hand, slight morphological variations begin to appear but such a change does in no instance alters the other cultural and serological characteristics. This is significant in so far as this drink is consumed in the raw state and the dilution factor does enter inasmuch as the vendors deliberately dilute the juice before sale for reaping greater profits.

S. paratyphi.—This organism is less tolerant to this medium and dies out within about four days even in the filter-sterilized and highly diluted samples. Growth is observable only for a day and thereafter both motility and the Gram reaction are altered. The bacterium begins to exhibit a slight tendency towards Gram-positive character. Furthermore, there is a tendency for the cells to agglutinate, and to show a halo-like capsule, but the biochemical reactions have always confirmed the identity of the cells. Moreover the variations in morphology change on subculturing in suitable media to yield normal characteristics.

In the steam-sterilized samples the growth is even poorer and is limited only in the higher two dilutions. Even therein the organism can live only for a day normally ; abnormal characters in morphology and a tendency towards Gram-positiveness in staining become apparent after a day of growth. Cultural changes also become evident in the appearance of rough and irregular colonies on subcultivation and the irregularities indicated in the agglutination tests. It is reasonable therefore to assume that sugar-cane juice is not a favourable medium for the paratyphoid A organism.

Even though the nonsterile samples appear to be better suited for this bacterium in so far as its longer viability period is concerned, other experimental evidence seems to suggest that even the raw samples of the juice are unfavourable for the effective growth and maintenance of its normal characteristics. This observation substantiates the previous conclusion, *viz.* the unsuitability of this medium for the growth and dissemination of the Para A bacterium.

S. schottmuelleri.—This species is more tolerant than the previous one and grows well in the juice (filter-sterilized) for four days without any loss of motility or virulence. This is self-explanatory. In the steam-sterilized samples, on the other hand, both motility and the antigenic character get altered, especially in the four lower dilutions, wherein the viability period is about three days only. In the higher two dilutions the

maximum survival period is longer by one day, but even then the nature of the growth is not convincing enough to suggest the suitability of the juice as a very favourable one for the organism. In the raw samples, however, the organism continues to live upto six days in all the six dilutions ; but motility is interfered with within a day, and thereafter, short, long, distorted and vacuolated cells begin to appear. Oftentime a chain-forming tendency is even noticeable among the cells. In every case, however, the biochemical reactions have indicated that the changes are only superficial and not constitutional. In conclusion, it may be said that Para B, like the typhoid organism, may be a potential source of danger from the point of view of its existence in the juice.

S. enteritidis.—This organism behaves, in its tolerance, somewhat intermediate between the two other *Salmonella* species discussed above. When we take into consideration its growth, motility, viability, etc. in the filter-sterilized juice, we find that this organism retains fairly well all its characters as compared to the steam-sterilized samples wherein the motility becomes sluggish and other characters remain as they do in the case of Para B organism. Likewise, in the raw samples, *S. enteritidis* closely follows *S. schottmuelleri* species. It can live for six days and as such the cane juice may be factor in its dissemination.

S. dysenteriae. In a general way this bacterium lives better than *E. typhosa* in the two filter-sterilized samples of the juice. It grows very well for three days and continues to give viability tests positive for full six days. It gives normal subculture and sugar reactions, but there is undoubtedly a modification in the antigenic make-up of the bacterium. This is revealed by the agglutination tests. In the steam-sterilized samples, on the other hand, it cannot live for more than two days in the concentrated samples (50% and 100%) and can live for only four days in the other dilutions. Cultural work done every few hours show a period of multiplication and retention of the virulence despite some morphological alternations observable in the low-diluted samples. This suggests the probability of its presence in the juice as being prejudicial, if not altogether alarming, from the point of view of public health. Besides, the more significant observation that it can live for six full days in the raw juice (despite its own normal flora) suggests its adaptability, which if really is the case under the field conditions is a potential source of danger to human health.

S. paratyphenteriae (Flexner).—This organism behaves in the filtered samples more or less the same way as the previous species except for some morphological variations. Actually, this species appears to be less tolerant. This is more particularly evidenced from the steam-sterilized samples in which this bacterium lives rather indifferently even during the first 24 hrs of growth. In the undiluted sample only a few degenerated cells live till the next day, and these too give rough colonies agglutinable only partially. In the raw samples, on the contrary, the organism lives for about six days suggesting again the sharp difference heat can bring about in the quality and suitability of natural foods for the growth of pathogenic organisms. One more interesting feature is that in the undiluted and the 50% diluted samples the Flexner strain has to struggle for existence (amidst the normal flora) in addition to the handicap occasioned by the near-unsuitability of the juice. This goes to indicate that from the Flexner infection standpoint the sugar-cane juice is pretty "safe" as a drink.

E. coli communis.—The results obtained with this organism in the two filter-sterilized samples of the juice indicate that this species follows closely the *S. schottmuelleri* with regards to its viability, motility and growth in the subcultures. In morphology, however, *E. coli* exhibited all the variations it can undergo by assuming short, long coccobacillary, vacuolated, elongated and other distorted shapes : even a sort of capsulated form was exhibited occasionally. But all these forms are readily convertible into the normal form by suitable subculturing techniques. Altogether it can live for 4 days (tested for that period only) and it can and does multiply in the juice at least during the first 36 hours.

In the steam-sterilized samples *E. coli* behaves much the same way as in the filter-sterilized samples ; only, the growth is poorer and except in the highest two dilutions there is no evidence of growth after 3 days. From the morphological, cultural and antigenic characters standpoint, this organism shows a remarkable property of adaptability in so far as the latter two characters remains unaltered in the raw samples, which indeed constitute the more important ones from the field standpoint of view. Morphologically speaking also this bacterium retains its normal shape for a longer time in the raw samples than in the corresponding sterile samples ; besides the concentration

of the sugar in the juice has no perceptible influence on the species. All these observations, together, with the fact that this organism can multiply and live at least for four full days in all the dilutions of the juice lead us to only one conclusion, viz. that *E. coli* can and does remain potent in the cane juice and as such its presence in large numbers in it must be regarded, as we do in water analysis, as an index of faecal pollution.

V. cholerae.—In contrast to the other bacteria studied so far, this intestinal pathogen has a short viability period in this medium. This is surprising in one way in so far as saccharose, the chief carbohydrate constituent of the juice, is a fermentable sugar for this species, and provides the energy source; but from the acid accumulation standpoint this is a handicap. Actually, even in the filter-sterilized samples this bacterium can live only for 6 hours. The growth phase of the organism in the juice is immediately followed by the death phase. Active motility is lost within the first hour, and two hours sojourn in the substrate renders the cells immotile altogether. Within six hours the juice gets sterile again, but throughout the life span the cells retain their Gram character; yet they lose their agglutinability with specific antisera.

The steam-sterilized samples are even more unfavourable. There is no growth phase at all and the vibrios can live for only about three hours in the highest diluted sample (1:32). In the next dilution viz. 1:16 it can live for only 2½ hours; in 1:8 dilution for 1½ hours, a little less than 1½ hours in 1:4 and for only half an hour in the 1:2 and 100% solutions. This substantiates the influence of dilution on the viability and growth of these bacteria in the juice. In short steam-sterilized samples of the juice are very unfavourable to the growth and viability of the Cholera vibrio.

In the raw samples too the picture is much the same except that in the higher dilutions the maximum survival period is extended by two hours and in the 50% and the 100% samples the same is increased by only an hour. Otherwise in all other features the reaction is much the same. This clearly shows that this article of drink is "safe" from the point of cholera infection.

DISCUSSION

The foregoing experiments reveal that the dilution factor in the juice is a major one from the point of view of the multiplication and the maximal survival period of the intestinal pathogenic bacteria put to the test under the conditions existing in this laboratory. Undoubtedly the different species show their individual differences and it is very reasonable to assume that wide differences would also be shown by different strains of the same species. Since the dilution factor is introduced under the field conditions by the cane juice vendors in more than one way, and since there is every possibility of adapted strains in existence in nature, there is every probability of the sugar-cane juice serving as an important channel for the distribution of these intestinal bacteria. As has been shown before, the chances of the Cholera vibrios getting disseminated through this source is very remote for the simple reason that the vibrios fail to multiply in even the highest diluted samples, and in the more concentrated samples the viability period is so short that there is no possibility of the organism ever threatening an infection through this source. In the case of the Typhoid organism, on the other hand, there is every reason to believe that this species may get distributed through this medium in as much as the organism multiplies in the juice and has a comparatively long viability period. Besides, the finding that this organism retains its motility and other important characteristics in the raw samples especially suggests that it is a very adaptable species and as such may be concerned in the causation of specific infections under certain conditions. It is pertinent to mention in this connection that thus far three cases of infection (one of typhoid and two of food-poisoning) have been brought to our attention and all these three cases had their

suspected origin to this drink. This leads us to discuss the chances of the organisms of the food-poisoning group setting up the infectious process through this source. Studies in connection with the *S. schottmuelleri* in particular are convincing enough to suggest the extreme possibility of the food-poisoning group operating through this medium. Moreover, the recent work concluded in this laboratory (1948) in connection with water melon and food-poisoning has yielded convincing results to arrive at the conclusion that *S. schottmuelleri* is probably more concerned in this infection than the representative *S. enteritidis* species. From the point of view of bacillary dysentery this drink appears to be relatively a "safe" one.

SUMMARY

The possibility of the sugar-cane juice serving as a suitable medium for the growth and distribution of some of the intestinal pathogenic bacteria was put to the test by taking *E. typhosa*, *S. paratyphi*, *S. schottmuelleri*, *S. enteritidis*, *S. dysenteriae* (Shiga), *S. paratyphenteriae* (Flexner), *V. cholerae* and *E. coli communis* as the test species. It was revealed that whereas the first seven bacteria multiply in the juice and survive for fairly long periods of time, the Cholera vibrios disappear from the juice within one half to six hours after inoculation. It is pointed out that this drink may be a potential danger from the public health standpoint in as much as the typhoid and the food-poisoning group of bacteria not only multiply but remain viable, and, antigenically and otherwise complete in it for considerable length of time.

REFERENCES

- | | |
|----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Bhat, J. V. and Raghunath, M. (1948) .. | Curr. Sci., 17, 213 & 264. |
| Bhat, J. V. and Reporter, R. N. (1948) .. | Curr. Sci., 17, 183. |
| Bhat, J. V., Reporter, R.N., and Fernandes, F. (1945) .. | Jour. Univ. Bombay, XIV, Part 3, 53. |
| Buice, W.A., Schested, H.C., and Dinest, R.B. (1927) .. | Jour. Infect. Dis., 40, (2) 348. |
| Mackenzie, Douglas. (1930) .. | Lancet, 219, 789. |
| Reporter, R. N. (1944) .. | "Suitability of certain foods and drinks for the growth and distribution of some intestinal pathogenic Bacteria," M.Sc., Thesis, Bombay University. |

STUDIES ON THE INFLUENCE OF SOME BACTERIAL CULTURES IN THE NITROGEN STATUS OF SOIL

3. The Influence of *Pseudomonas aeruginosa* in the Nitrogen Status of Soil

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IN this paper we are dealing with yet another type of chromogenic bacterium, which not only is a common soil inhabitant but which we have observed to be a fairly common laboratory contaminant. Moreover this species in the soil under investigation was particularly in abundance. Before we proceed to study its influence in the nitrogen status of soil it is necessary, however, to point out here the main physiological activities of this bacterium. *Ps. aeruginosa*, is undoubtedly, one of the most powerful bacteria : it can liquefy gelatine, produce soluble organic pigments in large quantities, reduce nitrates even to elemental state (Maassen, 1901) and is at the same time one of the "most active denitrifying organism" (1901). It is known for its fixation of nitrogen in small quantities and is well known for its other active biochemical characteristics. It is natural therefore that the results obtained with this organism are strikingly different from those given by the bacteria reported previously in this Journal (1948).

After the preparation of the 36 experimental samples of the soil as detailed out in the previous paper (*loc. cit.*), 18 of the samples constituting the "inoculated" series were each inoculated with 0.1 cc. of young *Ps. aeruginosa* culture-suspension, numbering approximately 548,000,000 cells per cc. The flasks were then exposed to the different light-weather conditions for 30 days and at the end of it examined chemically for the nitrogen status and microbiologically for the viability of the bacteria inoculated. The results obtained are reported below.

1. DIRECT SUNLIGHT

Losses in Nitrogen contents expressed in p. p. m. of the soil : The +ve sign before the figures indicates a gain in Nitrogen

Moisture condition of the soil	Inoculated set		Sterile set	
	Total N.	Soluble N.	Total N.	Soluble N.
Dry	44.24	+81.60	105.40	30.34
Semi-saturated	88.20	+21.60	64.12	10.40
Water logged	88.20	+65.80	53.78	38.00

Conclusion.---As in the case of *S. marcescens* (see Bhat, 1948), there is in this case in the dry samples smaller losses indicated as a result of the bacterial action in spite of the fact that the loss recorded in the sterile series (due to chemical action) is comparatively high. *Ps. aeruginosa*, however, appears to be more active than the former organism and brings about a greater loss of soluble nitrogen as may be judged from the above results : simultaneously, a clear gain is observable in the soluble nitrogen. Yet, this gain, being greater than the loss that has occurred in the insoluble nitrogen from the corresponding samples, cannot be explained on the basis of its being formed from the insoluble nitrogen alone ; obviously, the process of nitrogen fixation comes into operation in this instance also. The overall results indicate the desirability of this bacterium in the soil from its nitrogen status standpoint. It must be added in this connection that this bacterium could live in the soil (even in dry samples exposed under the sun) for a month under all experimental conditions.

The results of the semi-saturated samples further emphasise one of the conclusions drawn before, *viz.*, that this organism is definitely more potent in its action than *S. marcescens*; for, despite the retentive action of moisture on the soluble nitrogen, a greater loss has taken place in the total nitrogen of the inoculated samples and this loss is not commensurate with the gain observable in the soluble nitrogen. In other words, whereas in the previous instances the activities of the bacteria have resulted in the gain of soluble nitrogen which is co-relative with the loss in the insoluble form, in this case the gain in the soluble nitrogen is not at all appreciable as compared to the heavy losses in the insoluble nitrogen. To express it on a quantitative basis, the soil has lost 24.08 p. p. m. (88.20-64.12) of the total nitrogen to a detectable gain of 21.60 parts of the soluble nitrogen : This loss, it is evident, is greater than that can be accounted for as due to the chemical action alone. The difference in these figures therefore explains to some extent the nitrogen metabolism in the soil, including a pointer to the rough measure of nitrogen utilized by the cells for their cell-synthesis.

Considering the water logged nature of the soil and the pigment producing character and the denitrifying function of this organism, we should expect in this case a relatively greater loss in the total nitrogen ; but actually, we see that the loss in nitrogen is of the same magnitude as in the semi-saturated samples, and contrary to expectation, there is a

greater gain recorded in the soluble nitrogen. This evidently is due to the nitrogen fixation activity of the bacterium under study. It should be noted that a greater loss due to the chemical action in the soluble nitrogen has occurred in this instance as compared to the semi-saturated, and the plausible explanation for this anomaly has been forwarded previously.

2. DIFFUSED LIGHT

Losses in Nitrogen contents expressed in p. p. m. of the soil : The +ve sign before the figures indicates a gain in Nitrogen

Moisture condition of the soil	Inoculated set		Sterile set	
	Total N.	Soluble N.	Total N.	Soluble N.
Dry	285.60	+44.00	87.04	60.68
Semi-saturated	154.00	+21.60	44.24	24.26
Water logged	107.96	+87.64	129.40	24.26

Conclusion.—The conclusions drawn before in connection with the dry samples kept under direct light hold good in this case also. The gain observed in the soluble nitrogen as a result of the bacterial action is not at all appreciable as compared to the loss that has occurred in the total nitrogen. This further amplifies the powerful action of *Ps. aeruginosa* on the insoluble nitrogen. The inference that may be drawn from the semi-saturated samples also goes to show that from the soil nitrogen standpoint this bacterium can deplete appreciable quantities of insoluble nitrogen. Another point which becomes obvious from these results is again the retentive action of moisture on the nitrogen status. So far as the water logged samples are concerned, the presence of this organism in soil appears to be actually beneficial to the soil ; for not only there is a smaller loss indicated in the total nitrogen of the inoculated samples (as compared to the sterile) but there is also an appreciable increase in the soluble nitrogen and which can be attributed to the nitrogen fixation process. It should be remembered in this connection that although oxygen is necessary for chromogenesis, the relation of this organism to air is such that it can well be a facultatively anaerobic type.

3. DARKNESS

Losses in Nitrogen contents expressed in p. p. m. of the soil : The +ve sign before the figures indicates a gain in Nitrogen

Moisture condition of the soil	Inoculated set		Sterile set	
	Total N.	Soluble N.	Total N.	Soluble N.
Dry	88.20	+108.60	50.66	18.88
Semi-saturated	206.82	+65.80	186.56	56.28
Water logged	185.72	+87.64	106.00	24.26

Conclusion.—The above results bring out two points in prominence, *viz.*, (1) the nitrogen fixation activity of the organism, and (2) the depletary activity of this culture in the soil nitrogen. The former is made clear in every case wherein the amount of the soluble nitrogen formed, as compared to the losses indicated in the corresponding sterile set, is more than that can be accounted for on the basis of the formation of the soluble nitrogen from the insoluble alone. To illustrate this point, let us take the dry samples: we observe a loss of 27.54 (88.20—50.66) p. p. m. in the total nitrogen against a gain of 127.48 (108.60+18.88) p. p. m. in the soluble nitrogen due to the bacterial activities. Now the gain recorded in the soluble is much more than the loss that has occurred in the total nitrogen and has to be therefore accounted for. To what other activity can this be attributed to than the nitrogen fixation?

So far as the latter point is concerned it is clear, from the above results, that even though there is a distant gain in the soil nitrogen in all the three differently treated samples as a result of the bacterial activity, it cannot be denied that there is, in all those three cases, appreciable loss indicated in the corresponding samples for the total nitrogen. It may be pointed out in this connection that this loss is much more pronounced in the wet samples than in the dry and is presumably due to the denitrifying activities of the organism. On the whole, it may be concluded that the presence of *Ps. aeruginosa* in soil under darkness is beneficial to soil inasmuch as the insoluble nitrogen is being rapidly converted into the soluble form; this is particularly emphasised for soil in a dry state.

SUMMARY

1. From the point of view of soil nitrogen, direct light is less harmful to soil inoculated with *Ps. aeruginosa* than the diffused light condition or complete darkness.
2. Moisture to the extent of semi-saturation brings about greater loss in soil nitrogen when *Ps. aeruginosa* is present as the only species in soil.
3. In all the samples an increase in the soluble nitrogen contents is indicated; but this in no way is co-related with the decrease in the total nitrogen.
4. *Ps. aeruginosa* does exhibit nitrogen fixing capacity in soil under most of the conditions studied.

REFERENCES

- Bhat, J. V. and Palacios, G. (1948). Jour. Univ. Bombay, XVI, part 5, Sec.B, 15.
- Maassen, A. (1901) as cited by Waksman in "Principles of Soil Microbiology."
- Sewerin, S. A. (1901) Central. Bakt. II, 3, 504.
- Waksman, S. A. (1932) "Principles of Soil Microbiology," 2nd Ed. Bailliere Tindall & Cox.

PROFESSOR F. O. BOWER

ON April 11, 1948, Professor Frederick Orpen Bower, a distinguished figure in English Botanists since the Victorian days died at an age of 93. Born at Ripon (Yorkshire) on 4th November, 1855, Prof. Bower came from a distinguished family, his mother being the daughter of a Rear-Admiral, which perhaps may account for the high aristocratic look and bearing he always had. He was educated at Repton School and was fond of Natural History, collecting nests of birds and plants. In 1874, he went to Cambridge to study at the Trinity College and took his tripos with first class honours in Botany.¹

The teaching of Botany in English Universities then consisted largely in giving elaborate instruction in Plant Morphology and Taxonomy under the influence of great systematists of those days such as Babington, Thistleton-Dyer, Daniel Oliver, Hooker, Bennet, etc. Two main features of English Botany then were a zeal for the exploration and exploitation of plants for the needs of the empire and the idea of descent through variations emanating from the epoch-making work of Sir Charles Darwin, "*The Origin of Species*" published in 1859.

Such was not, however, the case in Europe. The French botanists under the influence of Bornet and Thuret were busy unravelling the secrets of the life histories of marine algae and were also building a school of Palaeobotany under the leadership of Renault known for his work on *Sphenophyllum* and Botryopteridineae at Paris. The German school was far ahead of these busy developing elaborate laboratory technique, working out life histories, describing the detailed anatomical structure of living and fossil plants, unveiling the cell phenomena, thus gradually building a powerful school of experimental Botany or what came to be called "Physiological Botany" later. This was mainly due to the efforts of Hofmeister who had died recently then in 1877, von Möhl, Sachs, De Bary, Radlkofer, Strassburger, and others. To quote Bower's own words (1925, p. 131), in those days "Cambridge was tiddling with details while Leipzig and Heidelberg were burning with a new synthetic flame." Bower not being satisfied with the terse and prosaic teaching of Botany in England, even as an undergraduate lad went to Germany in 1877 with S. H. Vines, who was his senior at Cambridge, to learn first hand the methods of experimental work developed in the German Universities. Here he had the rare opportunity of working under Sachs at Würzburg and then under De Bary at Strassburg. Sachs was a teacher of great repute. He was known for his eloquent lectures, picturesque illustrations drawn off-hand in the class with the skill of a trained artist, he himself being the son of a wood-cut artist, for his great mastery over expression and lucidity of style and for his skill in handling the physiological apparatus. He was friendly to Vines, Scott, Bower and others who went to study under him, and here they met Goebel, Zacharias, Klebs, Schimper, Büsgen, Farlow, Zimmermann and others, direct or indirect descendants of Hofmeister's School. They all imbibed enthusiasm for research and practical work in the laboratory from Sachs. Bower worked under Sachs in 1877 and under De Bary in 1879-80. De Bary well-known for his masterly treatise on the comparative anatomy of the phanerogams

and ferns was not as good a lecturer as Sachs ; but his lectures were very substantial and well illustrated with carefully chosen material. Naturally all these men made a profound impression on young Bower who tried to absorb much of the developmental and comparative anatomical methods advanced by the German workers such as Radlkofer and his school and French workers such as Endlicher, De Candolle and Martius who had successfully used them to solve some problems in plant morphology and taxonomy.

De Bary was also a great believer in developmental studies. "Key to plant form lies in its development," he used to say. Sachs was very particular about drawings. "A drawing conveys a view," he used to say and would insist on detailed figures carefully drawn. He would cryptically say, as Scott (1925, p. 10) has put it in his reminiscences of the German Universities, "Was man nicht Gezeichnet hat, hat man nicht gesehen." One can easily imagine with what impressions Vines, Scott and Bower must have returned to England from the German Universities, where, as Scott (*loc. cit.*, p. 18) and Vines (1925, p. 3) have rightly pointed out, routine teaching was altogether secondary to research, and every student was given a fair chance to be a potential investigator. Dominance of research over mere bookish learning was the core of German tradition and I suppose it is still so to-day.

This direct contact with the makers of the German Botany created a new outlook in Bower and others; and when they came back, he started his career as an assistant to Daniel Oliver at the University College, London, and later lectured under Thomas Huxley, the famous protagonist of Darwinian doctrine of descent. With the help of Huxley, who was also a very good teacher, Bower Scott and Vines were able to change the outlook of English botanists by introducing intensive practical training, making the subject more interesting and real. It was during these early days that Bower worked for long hours in the Jordell Laboratory at Kew and prepared elaborate notes for his studies on the phylogeny of ferns and the spore producing parts of the Pteridophyta. In 1885, he took up the chair of Botany at the University of Glasgow and with the exception of six months spent in Ceylon in 1885-1886, continued to occupy it till he retired from it in 1925 as the *Regius Emeritus* Professor of Botany. All those who have heard him say that he was an inspiring teacher creating a good deal of enthusiasm for research in young inquisitive minds. The whole school of Cryptogamic botanists in England led by doyen amongst them, Professor W. H. Lang of Manchester, owes allegiance to Professor Bower for his teaching.

Professor Bower hated early specialization and lop-sided training. All his works are full of facts drawn from all sources and groups of plants and speak volumes for the width of vision and comprehensive outlook he had. In fact few botanists could present the subject so well and with such zeal, cogency of thought and clarity of exposition as Bower does. My teacher, the late Professor D. L. Dixit of Poona (alas ! who is no longer in our midst : he died at Poona on 3rd July last, 1948), always used to remark to us : "Professor Bower never merely writes : he presents his view-point with a force, and pleads for his ideas with the skill and zeal of a trained barrister." Those of us who are conversant with the details of the controversy over the morphological nature of the Ophioglossaceous spike between Bower (1908, 1911) and Chrysler (1910, 1911) will readily agree with the remark of Professor Dixit given above. And yet as Chrysler (1911, p. 152) himself has said, Bower had that candour

characteristic of a true scientist with which he readily assimilated new facts and changed his opinions in their light. His "*Sixty Years of Teaching of Botany*" (1938) and other narratives are full of interest to all students of History of Botany. His classical works, "*The Origin of a Land Flora*" (1908), "*The Ferns*" (1923-1928), "*The Plants and Man*" (1930), "*The Size and Form in Plants*" (1930), "*The Primitive Land Plants*" (1935) evince a great mastery over a very wide range of facts and data, and above all the philosophical approach he had imbibed from the German masters.

Prof. Bower was a man of very high standards of attainment as all his works testify. He did not allow mediocres to come near him, being a man of strong likes and dislikes. Besides Botany, he was interested in music which he liked next to science, and in mountaineering. He would work very hard for all his undertakings and would see to the last detail himself: and he would expect the same amount of carefulness and caution from others. It appears he maintained this habit till the last. He himself brought up-to-date his *magnum opus*, "*The Botany of a Living Plant*" by adding new chapters to the 4th edition and even looking through some of the proofs when he was 92. Only last year in a letter written to me in his usual clear hand in reply to one of mine, he readily gave me some hints for my work on *Ophioglossum* and in his very characteristic manner he added:

"You must not expect much help from me. I am over 91 years old: retired for over 25 years. You must depend on your own self work, as I did when young like you."

His numerous papers provide ample food for further work. Like Sachs, he exercised tremendous influence on contemporary Botany, though both of them changed their opinions on certain problems several times. For example, there was a time when Bower's antithetic theory of alternation of generations in plants was holding ground firmly for over thirty years from 1908 to 1938, when Holloway's (1938) remarkable paper on the embryo and prothalli of *Psilotum* in which he found some tracheids in the prothallus appeared in the *Annals of Botany* (New Ser. Vol. 2, pp. 807-808, 1938) and gave a shock to the current opinion which now tends to be more favourable to the homologous theory. But that in no way minimises Bower's influence on the contemporary thought. And this is what it ought to be so: for, in a growing science like Botany aiming at solving the mystery of plant life, we can never utter a final word in any problem. Such are the apparent simplicity and automaticity of protoplasm in plants and their reactions to environment through space and time.

It is difficult to replace such a man. He with Vines, Scott and Huxley revolutionised the outlook of English Botany 70 years ago by introducing systematic laboratory training in the University curricula, which was then largely a German legacy, but is now followed everywhere. With the exception of Professor Haberlandt, who is still living, Bower is one of the few botanists who saw the Darwinian and Hofmeisterian schools coming into existence, rising and flourishing before their own eyes. Botany has since then undergone marked changes and now has a tendency to atomise like physical sciences in modern times. From mere formal discussions of early taxonomists it became circumspective and experimental at the hands of Hofmeister and Sachs respectively, and from mere comparative parallelisms leading to speculations on plant phylogeny at the hands of the last century botanists, it has now become more comprehensive and dynamic in its outlook and methods. Consequently, the gap from Hofmeister (1877) to Bower (1948) is a large one: much larger than

the time gap of intervening years would indicate. Professor Bower was fully alive to all these changes as could be judged from his recent article, "The Morphological Kaleidoscope" in the *Iyengar Commemoration Volume* of the Jubilee session of the Indian Botanical Society, 1946. In the concluding paragraph of this article he writes :

"Within the last century of the morphological guesses and preconceptions, such as those of Goethe, should have passed away. Even cold formal comparison of plants, living or fossil is worn out. The attack should now be along lines of consecutive reasoning, based on a knowledge of the processes of growth and function. This should be carried out inductively from simpler types upwards : and aided or checked as the case may be by palaeontological fact. Unfortunately neither the demise of an age of guesses, nor the birth of an age of inductive method upward, has been universally accepted as ruling the practice of progressive morphology."— p. 16.

Ah, what a change from the static outlook of the Victorian age to one of intensive activity for solving the fundamental problems in plant morphology, by unknown new roads full of promise for the younger branches of botanical science such as Cytology, Genetics, and Experimental Morphology. The task set out by Bower is not an easy one. The old ideas sit too tight on us and the new ones are too amorphous to fit in readily within the frame-work of the current morphological thoughts. But one need not be despaired if one only knows how to be in the main stream of botanical research. Bower's death certainly does not mark the end of the Hofmeisterian school : it rather denotes the advent of a new progressive experimental morphology of the years to come.

Professor Bower was a member of numerous learned bodies all over the world and received several honours. He had a kindly eye on Indian students and was associated with the Indian Botanical Society which elected him one of the Honorary Members in 1933. As the Secretary of that body and as one who has derived greatest inspiration from Professor Bower's writings, I take this opportunity to pay my homage to the memory of this great botanist of our times.

The photograph reproduced here is from a photograph in Professor Birbal Sahni's Laboratory at Lucknow and bears Professor Bower's autograph with the year 1928. I am much indebted to Professor Sahni for this photograph.

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August 15, 1948.

T. S. MAHABALE

1. In the preparation of this note I have freely consulted Prof. Bower's "*Sixty Years of Teaching of Botany*" (1938), *Reminiscences of the German Universities and Botanical laboratories* by S. H. Vines (1925), D. H. Scott (1925), F. O. Bower (1925), *New Phytologist*, Vol. 24, pp. 1-8, 9-16, and 129-137, *Nature*, Vol. 161, pp. 753-755, 1948 and other information scattered in the botanical literature.
2. Bower, F. O. (1925), *New Phytol.*, Vol. 24, pp. 129-137.
3. Scott, D. H. (1925), *New Phytol.*, Vol. 24, pp. 9-16.
4. Bower, F. O. (1908), *The Origin of a Land Flora*; *Ann. Bot.*, Vol. 25, pp. 277-298; "*Primitive Land Plants*" (1938).
5. Chrysler, M. A. (1910), *Ann. Bot.*, Vol. 24, pp. 1-18.
6. ——— (1911), *Bot. Gaz.*, Vol. 52, pp. 151-153.
7. Holloway, J. E. (1938), *Ann. Bot.*, New Ser., Vol. 2, pp. 807-808.
8. M. O. P. *Iyengar Commemoration Volume* of the Jubilee Session of the Indian Botanical Society, 1946, edited by Professor B. Sahni, pp. 9-17. Compare this article with chapter XI, pp. 84-97 bearing the same heading in Bower's "*Sixty Years of Teaching of Botany*" (1938). Here again Bower has reviewed all facts gathered since 1938 to 1945 and has brought his ideas up-to-date.



Professor F. O. Bower
(1855 — 1948)

A CONTRIBUTION TO THE STUDY OF THE ROOT HABITS AND ANATOMY OF INDIAN PLANTS

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(With 28 plates, 40 photographs and 247 figs.)

PART I

INTRODUCTION

GENERAL REMARKS.--Although the knowledge of the above ground parts of plants has advanced considerably the study of roots of Indian plants remains at best a virgin field. Apparently the great amount of labour and time involved in the excavation of these organs seems to be the principal deterrent factor to such investigations.

While a great deal of progress has been made in Europe and America on the study of root habits of trees and shrubs (11, 34, 38, 75, 76), weeds (24, 63), alpine plants (28), desert plants (20, 55), and recently the work of Cannon (20), and of Weaver (93, 94, 95, 96, 97), has attained classical value, in India research in this direction has compelled relatively little attention and remains markedly deficient. In fact, so far as the writer is aware, Somasundaram (84) seems to be the only investigator to describe root habits.

In regard to anatomy, Artschwager (4) has given us an excellent account of the ontogenetic anatomy of the Beet root. Liermann (51) has produced a treatise on the comparative anatomy of the roots of some pharmaceutically important Umbelliferae. Schröder (78) has investigated the roots of meadow and pastureland plants from a comparative anatomical viewpoint. But apart from these and a slight summary by Solereder (83) devoted to the root at the close of his Systematic Anatomy of the Dicotyledons and Arber's (3) contribution to the study of some Monocotyledons, not to mention scattered references to roots in the general botanical literature (7, 27, 31, 32, 36, 42, 43, 48, 83, 85) and a few papers on tubers (8, 18, 30, 41) apparently little work on roots from an anatomical standpoint has been undertaken outside India.

In India, studies in root anatomy have also been scanty. Even Sahnis (73) in his otherwise exhaustive treatise on the anatomy of the plants of the Indian Desert has for obvious reasons omitted the root.

With the exception of some information in recent papers by Singh (79), Banerji (6), Chauduri and Akhtar (23), Majumdar, (54), Joshi, (45), Parija and Misra (62), literature in this regard is far from satisfactory.

The investigations herein reported attempt to contribute to the study of the root habits and anatomy of Indian plants in the hope that such data may serve for a better understanding of plant ecology. The results of this research are based on the study of 33 species representing various genera and families found in the vicinity of Bombay and in the Salsette Island an area which has a vegetation that ranges from grassland to typical deciduous forest.

Arrangement and Method.—The anatomy of the root of each species under study is dealt with separately and is entirely the contribution of the present writers. While other features have been reported, special stress has been laid on tissues which have an adaptive significance. The anatomical description of each plant is preceded by a note on the general characteristics of the plant, including the root habit, gathered partly from personal observation and partly from the Floras and other allied data (12, 13, 25, 61, 86, 88).

An attempt is made to confirm the various root habits to the life forms recognised by Raunkiaer (67) and others (17), and thus to present an evolutionary series based on anatomy grading from the primitive Phanerophytic types to the extremely advanced Cryptophytes. Accordingly the present writers propose the following classification of life forms :—

Scheme of Life Forms

I. PHANEROPHYTES :

A. Erect :

1. Without specialised underground storage organs :

a) Evergreen :

Phoenix sylvestris Roxb.
Zizyphus Jujuba Lamk.
Anacardium occidentale Linn.
Mangifera indica Linn.
Buchanania Lanza Spreng.
Ixora alba Linn.
Carissa carandas Linn.
Lantana Camara Linn.
Vitex Negundo Linn.

b) Deciduous :

Careya arborea Roxb.
Vangueria spinosa Roxb.
Bridelia retusa Spreng.

2. With specialised underground storage organs :

a) Evergreen :

Leea Sambucina Willd.
Datura fastuosa Linn.

b) Deciduous :

Gossampinus malabarica Merr.
Lannea grandis Engl.

B. Scandent :

1. Without specialised underground storage organs :

a) Evergreen :

Clematis Gouriana Roxb.
Rivea ornata Choisy

b) Deciduous :

Smilax macrophylla Roxb.

2. With specialised underground storage organs :

a) Evergreen :

Vitis repanda Wight and Arn.
Vitis trifolia Linn.

b) Deciduous :

Pueraria tuberosa DC.

C. Succulent :

Plumeria acutifolia Poir.
Euphorbia neriifolia Linn.
Pedilanthus tithymaloides Poit.
Jatropha Curcas Linn.

II. HEMICRYPTOPHYTES :

A. Erect :

1. With specialised underground storage organs :

Leea crispa Linn.

B. Scandent :

1. With specialised underground storage organs :

Vitis latifolia Roxb.
Holostemma Rheedianum Spreng.

III. CYRPTOPHYTES :

A. With perennial underground root tubers :

Leea macrophylla Roxb.

B. With tubers lasting one unfavourable season :

Curcuma pseudomontana Grah.*Curcuma zedoaria* Rosc.*Habenaria commelinifolia* Wall.

In this scheme as no representatives of CHAMAEPHYTES and THEROPHYTES have been studied these groups are not shown. The scheme as it stands indicates the possibilities of elaboration of Raunkiaer's system of life forms.

In the body of the work, therefore, the appropriate plants are treated in the order in which they fall in the scheme outlined above. The descriptions are illustrated by diagrams, photographs, photomicrographs and camera lucida drawings. Wherever practicable, the interpretations of the various structures observed and described, as well as the conclusions drawn therefrom, are embodied in the descriptions of the individual plants. In the conclusion an attempt is made to co-ordinate the information and summarise the results.

N.B.—Habit drawings of most trees have been taken from very young plants.

DESCRIPTION

Phoenix sylvestris Roxb.

I. *General Remarks and External Features.*—The Wild Date Palm of India is a very handsome tree about 10-12m. high. Its trunk is rough with the persistent bases of leaf stalks and is surmounted by a hemispherical crown which is very large and thick (12). The tree is tolerably common throughout India, wild or more often cultivated. In the Bombay Presidency, it is common on moist ground throughout the dry districts usually along banks and in beds of streams and water-courses (25, 86).

After germination, the primary root soon perishes and is replaced by adventitious roots arising from the base of the stem. The stem of the young plant is at first very slight and it is some years before it appears above ground. As growth proceeds, the growing point becomes larger and more vigorous so that the stem assumes the form of an inverted cone which is kept in position by numerous adventitious roots (Photo I ; Pl. A : Fig. 1 a). Later, the continuous enlargement ceases and the upper portion of the stem remains cylindrical. In older plants the base of the trunk below the cylindrical part shows an increase in girth causing a gradual tapering upwards. This phenomenon has been explained by De Bary (7) as being due to an increase in volume of the

existing tissue elements. This may, to some extent be true, but to the present writers it appears that the increase in diameter in *Phoenix sylvestris* is due also to the pressure exerted by the large number of vigorously growing, obliquely directed adventitious roots which, in forcing their way out, cause a bulging of the stem-base (Pl. A : Fig. 1 *b*). An examination of an old trunk revealed a great mass of pent-up vigorous roots which had not been able to force their way out and had added to the girth of the base of the stem in this region. In still older parts, increased production of adventitious roots in the basal portion of the trunk causes the rind ultimately to burst open from below upwards exposing the stout adventitious roots which grow down obliquely. Those nearest the soil penetrate it ; others higher up stand out obliquely from the trunk downwards (Pl. A : Fig. 1 *c*). The stout roots give off thin, whitish tough, elastic laterals which are varicously disposed (Pl. A : Fig. 2). Most of them are negatively geotropic and upwardly growing (*a*). There are also thinner branch roots from the upper surface of these roots with no special direction of growth (*b*). Thus there are three types of roots in *Phoenix sylvestris* as reported by Bloch (14) for *Phoenix reclinata* Jacq.

In India, where there is a definite periodicity in the seasons and a dry season of longer duration alternates with a relatively short wet season the general appearance of the subaerial root system varies with the season. In the monsoons every year there is a fresh growth of young soft roots added to the base of the trunk and it is evident that these roots function actively. Whether they play any special part in aeration, it is difficult to say. Doubt has recently been cast as to the aerating function of these roots by Bloch (14). As a matter of fact, the structures, especially of the aerial parts of the roots, seem to contradict this view, but there still remains the possibility that these roots are a relic of the times, when, under different conditions of life, they may have performed the function of aeration. There is no doubt, however, that the fresh growth of roots in the rains takes place in response to the conditions of humidity obtaining in the soil at this season. The whole mass of roots investing the trunk at its base is greatly predominated by the upwardly growing aerotropic roots which are closely webbed together so as to form nests capable of holding moist debris washed down by the rains, a circumstance which suggests that absorption is a possible rôle of these roots. In the dry season the roots become indurated but their hard remains persist, adding each year to the girth at the base of the stem, thus contributing to the mechanical requirements of the trunk which in this part is subjected to flexion due to the swaying of the crown. Altogether, the root system forms a dense interweaving mass closely attached to the base of the trunk in such a way as to fortify and buttress it (Photo II). The underground root system is also considerable and extensively branched and together with the subaerial roots affords efficient anchorage, capable of withstanding tensile strains. Conspicuous root caps are present on all roots. Root hairs may occur in the underground parts.

II. *Internal Structure*.—(Photos III—VIII; Figs. 3-29). The anatomical study of Palm roots has engaged the attention of Von Muhl (59) Karsten (47) and Drabble (29). Special work on Palm roots has been done by Cermack (26) who has reported polystely in the aerial roots of certain species.

A transverse section of the adventitious roots of the seedling of *Phoenix sylvestris* Roxb. (Photo III ; Figs. 8-12) has a circular outline. The outermost layer is made up of large cells with the outer walls dome-shaped, thickened and slightly lignified and the inner and radial walls unthickened. Beneath it is a hypoderma of about three layers of thin-walled polygonal cells with slightly lignified walls, followed by a zone of three or four layers of thickwalled polygonal cells, pronouncedly lignified and holding yellowish peg-like formations projecting into their lumina. These structures, according to Kuster (50) in his study on *Phoenix reclinata* resemble the membrane thickening associated with degeneration. The rest of the cortex is divisible into two parts, viz. an outer, more compact region of four-five layers of thinwalled, unlignified parenchyma with few interstitial spaces and an inner one consisting of thinwalled parenchyma with cells showing a tendency to radial elongation and traversed by radially arranged lacunae, formed partly by the separation of radially arranged rows of cells and partly by the collapse of some of these cells. Large, isolated cells—excretion cells, according to Richter (68)—holding acicular raphides of calcium oxalate associated with yellowish brown contents occur in the outer cortex. Small fibrous sclerenchymatous bundles—fibrous bundles according to De Bary (7)—are sparsely distributed in the inner portion of the cortex. The endodermis is composed of compact cells with thickened radial and inner tangential walls designated as Russow's "C" type by Haberlandt (36). The pericycle is one-layered and thin-walled. The stele is mostly 12-arch, with the xylem and phloem masses radially disposed and separated by conjunctive tissue composed of sclerosed fibres holding brownish contents. Each xylem group consists of 3-4 tracheids arranged in a radial plate and terminating in a relatively large metaxylem. The protoxylems of neighbouring xylem groups occasionally bifurcate, with a single common metaxylem. The phloem groups are less conspicuously developed. The centre of the stele is occupied by a parenchymatous pith with intercellular spaces blocked with black contents.

A transverse section of the aerial portion of the vigorous adventitious root (Photo IV ; Figs. 4, 13-15) shows the following structural features :—A few small root hairs in the form of stumpy protuberances with thin walls are found on the younger portions of the roots. Similar protuberances, according to Milne (58), have been observed in *Phoenix dactylifera* Linn. growing in well-drained soil where the water level is 80 ft. deep. There is a fairly broad band of lignified hypoderma of 5-6 layers. The cortex is compact. It is made up of oval or rounded thinwalled, unlignified cells separated by small triangular interstitial spaces. Numerous fibrous bundles are scattered throughout the cortex and disposed somewhat concentrically. The endodermis is thinwalled and unlignified with its cells almost squarish or rectangular in transverse section. The stele is 38-40 arch, with the xylem elements considerably reduced in size. Each xylem strand consists of narrow primitive elements towards the periphery with well lignified walls and larger internal vessels which show less complete development and a tendency to become isolated together with a portion of its surrounding conjunctive tissue from the peripheral part by loose parenchyma of rounded or oval cells which causes the conjunctive tissue to be fissured along these lines.

In portions of the aerial roots entering the soil (Photos V, VI ; Figs. 5, 16-21) which in India is liable to be periodically waterlogged, the following features are to be noticed. The hypodermal band is pronouncedly lignified. The cortex is lacunar with the cortical cells surrounding the lacunae forming a network supported by "fibrous bundles." In the neighbourhood of the endodermis the cortex tends to become more dense. The endodermis shows greater thickening and intense lignification, often with the lumina almost completely obliterated. The thickening layers of the endodermis are traversed by numerous branched canals which appear to communicate with corresponding pits in the neighbouring cortical and adjacent pericyclic cells. The stele is as much as 53-55-arch. The larger elements of the xylem are often seen to be traversed by multiperforate plates. Similar multiperforate plates have been reported to occur in the roots of Palms by Von Mohl, cited by Tangl (87) and in some Monocotyledonous and Dicotyledonous roots by Kundu (49). The isolation of the larger central vessels from the peripheral part of the xylem strands and from one another is seen to be more complete in the underground part than in the aerial portions. Each vessels with its accompanying conjunctive tissue forms a polygonal area bounded by loose parenchyma.

The thinner upwardly growing aerotropic roots (Fig. 2, *a*) or the aerial portions of the thinner branched roots which show no special direction of growth (Fig. 2, *b*) cannot be distinguished anatomically. A transverse section of such a root (Photo VII ; Figs. 6, 22-26) shows the following structures :—The outermost layer consists of large cells which are tabular in cross section with outer walls considerably thickened and lignified. A brownish-black pigment often occurs in these cells. This substance in *Phoenix reclinata* Jacq. according to Richter (68) is tannin. Next follows a hypodermis of four-five layers of thick-walled feebly lignified cells, some of which are seen to have the peglike projections referred to above. This is succeeded by one-two layers of thinwalled unligified cells also containing peglike or U-shaped formations—wound gum, according to Weiler (98). This graduates into a sclerenchymatous zone of four-five layers of strongly lignified cells. The rest of the cortex is composed of more or less rounded or oval cells with intercellular spaces occasionally filled with blackish substance which is also present in many of the cortical cells. Large excretion cells are present, but hold no crystals. The innermost layers of the cortex form a dense zone of cells. Sclerenchymatous fibrous bundles of the cortex are arranged somewhat concentrically. The endodermal cells show a variation in the thickening of their walls. Whilst most cells are unthickened, a few show initial thickening and are suberised. The stele is about 15-17-arch. The xylem elements show moderate thickening and lignification. The lumina of the cells of the conjunctive tissue are occasionally filled with brownish contents. U-shaped formations are often seen to occur in these cells.

The thin roots arising from the vigorous adventitious roots and entering the soil (Photo VIII ; Figs. 7, 28, 29) differ from the negatively geotropic roots in having a distinctly lacunar cortex and an endodermis which is strongly and evenly thickened and lignified (Russow's O-type). Branched canals of the type observed in the endodermis of the vigorous ground root occur. The stele is about 20-24-arch.

The lacunar cortex of the ground roots is indicative of a hygrophilous habitat to which a plant of the type of *Phoenix* is periodically subjected. That it is to some extent produced as direct result of the influence of the environment is shown by the fact that the cortex in the aerial portions of the roots examined is compact and devoid of lacunae.

The type of endodermis also seems to be correlated with the type of cortex occurring in the part examined. The thickened endodermis is associated with a lacunar cortex whilst an endodermis with walls less strongly developed occurs where the cortex is more compact. Such a correlation lends support to the view held by Van Fleet (90, 91) that the quickest maturation and suberisation of the endodermis results from a constant fluctuation of moisture conditions and aeration such as a plant of the type of *Phoenix* would experience in the monsoon climate of India. The extent of development of the hypodermal exoskeleton in the various roots examined seems to be influenced by the mechanical requirements of the parts examined. The occurrence of the cortical fibrous bundles whose function is to secure inextensibility is explicable in the case of the main roots that anchor the plant to the ground. Their occurrence in the thinner branches, e.g. the thin, upwardly directed acrotropic roots can only be understood as an instance of the inheritance of an acquired character. It appears that the central cylinder is so constructed as to secure pliancy combined with tensile strength. This is brought about by the splitting up of the stele into strands with increased number of bundles. The polyarch stele with an extraordinary large number of bundles as seen in the ground roots is a step in this direction. Further loosening of the vascular strands is attained by the isolation and separation apart of the larger central vessels by the interpolation of loose parenchyma. Nothing, however, in the nature of the approach to the polystelic condition reported by Cermack (26) in some palms has been observed in *Phoenix sylvestris*. It will be noticed that the younger underground portions of the roots have a larger number of primary xylem bundles than the older aerial portions of the same root. This seems to be in conformity with the view held by Preston (65) and Liese (52) that in any particular species the number of primary xylem bundles is directly correlated to the potentiality for absorption.

***Zizyphus Jujuba* Lamk.**

I. *General Remarks and External Features.*—It is a small to moderate sized deciduous (almost evergreen) tree with drooping branches and stipular spines. It occurs throughout India and thrives in comparatively dry regions where it is often gregarious either in the tree form or in the bushy form in grasslands (88). The young plant has a long, tapering, cylindrical, wiry primary root with a few fibrous laterals (Pl. B). Older branched roots show transverse wrinkles with reddish bark coming off in flakes.

II. *Internal Structure.*—(Figs. 30-33). A transverse section of an old root reveals a periderm which is deep-seated in origin. It consists of a few layers of thin-walled phellem cells blocked with reddish brown contents. These abut against the phloem. The latter is mainly composed of concentric zones of phloem parenchyma alternating with

tangential bands of phloem fibres so that the phloem appears zonate. Phloem fibre bands form closer rings towards the centre but are seen to be separated apart peripherally. The greater part of the phloem, especially in the outer region, contains starch. It appears that ordinary sieve tissue elements alternating with fibres are first cut off, and in the innermost region of the phloem these elements may be recognised. But gradually a transformation of sieve tissue elements into phloem parenchyma takes place in the older zones, the cells dividing and enlarging, so that there is an increase in the dimensions of the zones both in the radial and tangential directions. The phloem parenchyma is of the nature of storage parenchyma and is abundantly packed with starch. It is the tangential expansion that causes the phloem fibre bands to separate apart as noted above. The wood is diffuse porous with moderate-sized vessels arranged in regular series, either, solitary or in radial rows of 1-7 or in nests, often with contiguous rays on one or both sides. Paratracheal parenchyma forms a faint halo about the vessels. It is usually a 3-4 seriate sheath which is frequently interrupted on one or both sides of the vessels by contiguous rays occasionally extending tangentially across the rays in 1-4 seriate bands of paratracheal zonate parenchyma which unites several vessels or ends blindly. Metatracheal parenchyma is sparse and scattered. Starch grains occur here and there in the parenchyma. Wood fibres are aligned in radial rows; the peripheral fibres are often flattened tangentially and frequently blocked with brown contents. The fibre walls show differentiation into outer and inner layers. The latter are seen to glisten and are apparently of a gelatinous consistency. Wood rays, uni- rarely biseriate holding orange brown contents often associated with abundant starch grains traverse the woody mass.

Anacardium Occidentale Linn.

I. *General Remarks and External Features.*—It is a tropical ever-green tree, a native of South America which has become naturalised in many places in India. It is often gregarious and thrives best in sandy dunes (88). In the Bombay Presidency it occurs in Bombay Island, Salsette and in the Konkan (25). The root system consists of a long, tapering tap root with very few laterals at the base (Pl. C).

II. *Internal Structure.*—(Photo IX; Figs. 34-37). Young roots could not be obtained. A transverse section of a somewhat old root about 6 mm. in diameter shows a periderm deep-seated in origin. The phellem consists of 3-6 layers of squarish, rather thickwalled cells blocked with abundant brownish contents. Beneath the periderm and interposed between it and the pericyclic groups of stone cells are 2-4 layers of oval, thinwalled cells, which it is difficult to say whether they belong to the primary cortex or to the phelloderm. Large resin-canals more or less flattened tangentially occur irregularly distributed in the outer phloem. The phloem consists of sieve tissue elements and phloem parenchyma and irregular-shaped phloem fibres. The thickening of the phloem fibre walls is not homogenous but shows what appears to be a mucilaginous differentiation on the inner side. Such fibres are of the type designated "mucilaginous fibres" by Anderson (2), Jeffreys (44), Eames and MacDaniels (31), Candlin (19) and

Harlow (37). Phloem rays are usually uniseriate and do not expand centrifugally. Starch frequently occurs in the phloem rays. The stele is 6-arch. The wood is diffuse porous. The secondary xylem is characterised by medium-sized vessels, not arranged in regular series, open or occluded with tyloses holding starch grains, frequently with contiguous rays on one or, less commonly, on both sides. The majority are solitary, the outer zone consisting of larger vessels and small nests in radial rows of two, rarely paired in the tangential plane. Paratracheal parenchyma forms a 1-2-seriate sheath and is frequently interrupted by rays contiguous to the vessels. Paratracheal zonate parenchyma is peripherally flattened. It is either contiguous to the vessels or separated from them by radial rows of fibres. Metatracheal parenchyma is diffuse. Starch grains occasionally occur in the wood parenchyma elements. Wood fibres aligned in radial rows are squarish or tangentially flattened. Wood rays are rather fine, usually uniseriate, rarely biseriate. The pith is composed of thickwalled polygonal cells holding starch and brown contents.

Mangifera indica Linn.

I. *General Remarks and External Features.*—It is a large evergreen tree with dark green coriaceous leaves and a dense rounded crown. It is cultivated throughout India and the tropics and is found wild in jungles. It has a stout, cylindrical tapering primary root with numerous well branched slender laterals concentrated near the base of the tap-root and spreading out more or less horizontally below the soil surface (Pl. D).

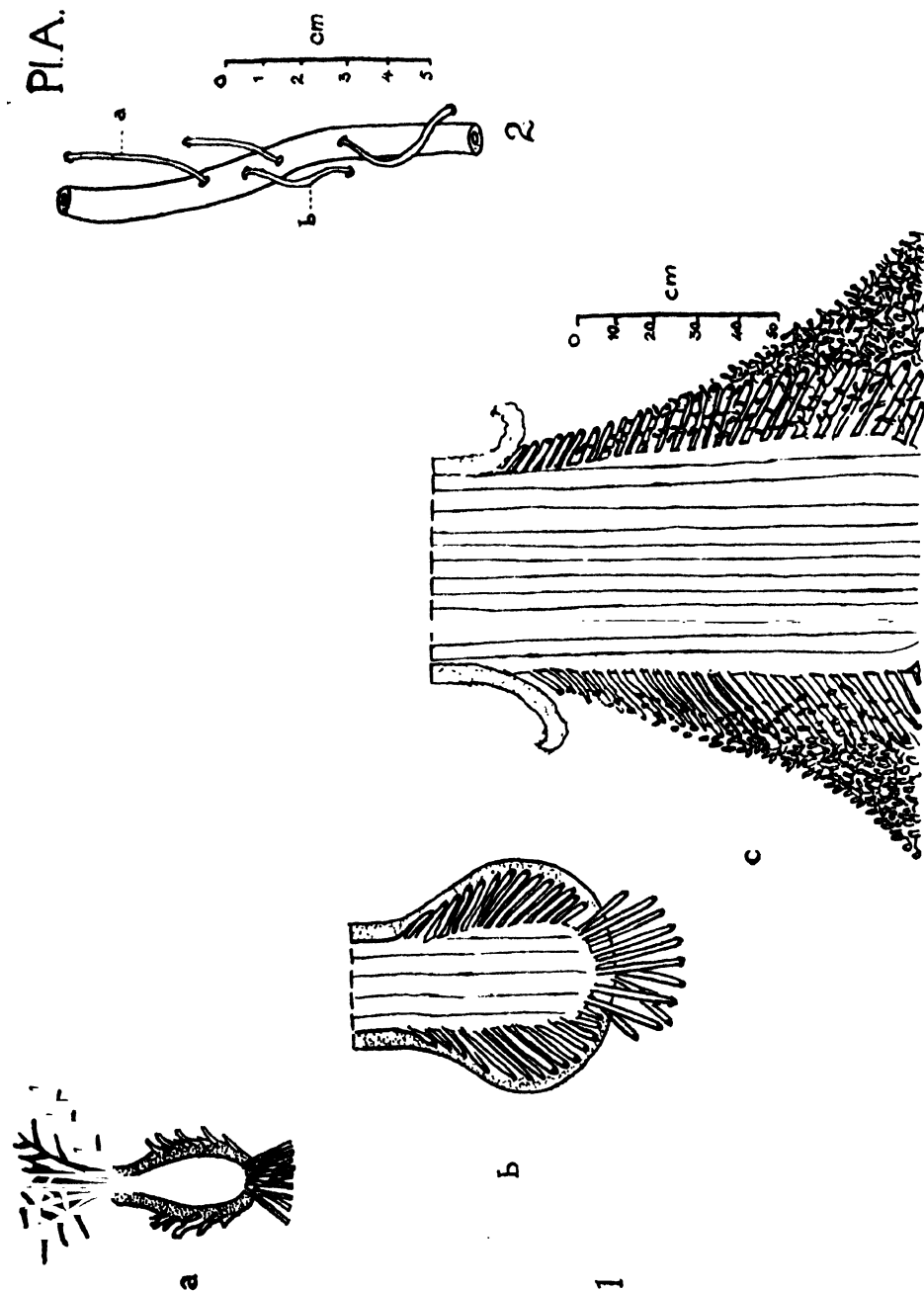
II. *Internal Structure.*—(Photo X). In a transverse section of a root about 6 mm. wide, the periderm is deep seated in origin. It consists of 6-10 layers of rather thickwalled, rectangular phellem cells blocked with brownish yellow contents. Beneath the phellem are 4-5 layers of oval or tangentially flattened cells which are continuous with the phloem rays. Greyish contents and solitary crystal idioblasts are evident here and there in this tissue. The phloem masses are dome-shaped. Large resin canals associated with mucilaginous fibres occur in the outer phloem. Crystal idioblasts are adjacent to the phloem fibres. Smaller resin canals occur in the inner phloem. The phloem is flanked on either side by phloem rays which broaden out somewhat centrifugally giving the phloem the dome-shaped appearance. The wood is diffuse porous. The secondary xylem is characterised by large vessels unevenly and somewhat distantly distributed. They occur singly or in radial rows of 2-3, rarely in nests of 6-8. The vessels or vessel-groups may have contiguous rays on one or rarely on both sides or may occur apart from the rays. The greater mass of the wood is composed of woodfibres and parenchyma. Wood rays, uni- or biseriate, occasionally containing starch grains, traverse the woody cylinder. In the wood of some roots there is an appearance of annual rings caused by zones of woody tissue remaining less lignified. As far as can be made out from old roots examined, the stele is six-arch. The pith may be large or small, according to the size of the root and consists of thick-walled lignified cells forming, together with the woody tissues, a solid cylinder.

Buchanania Lanza Spreng.

I. *General Remarks and External Features*.—It is a moderate sized, almost evergreen tree with a straight trunk. It occurs in the deciduous forests throughout the greater part of India and Burma. It has a long, thick, cylindrical tapering primary root bearing a large number of laterals (Pl. E.).

II. *Internal Structure*.—(Figs. 38-41). In a transverse section of a root about 6 mm. wide, the cortical layers are seen to be lost by the formation of a deep-seated periderm against the phloem. The phellem consists of 6-8 layers of squarish thinwalled cells blocked with abundant reddish brown contents. Apparently no phellectoderm is produced. Wide canals occur in the outermost region of the phloem. According to Solereder (83) these are balsam canals situated in the primary phloem. The secondary phloem is characterised by tangential bands of phloem fibres more or less concentrically arranged and alternating with masses of sieve tissue elements and phloem parenchyma containing abundant starch grains and lightish brown to reddish brown contents. Small resin canals are abundant in the phloem. Adjacent to the phloem fibres are solitary crystal idioblasts. A few crystals may be seen to occur in the phloem fibres. Phloem rays, packed with starch grains and rhombohedral crystals of calcium oxalate, broaden out slightly, centrifugally. The wood is diffuse porous and may, owing to the marked radial disposition of the vessels, be designated as radially diffuse porous. There is a slight disposition into annual rings caused by the differential thickening of the fibre walls. The vessels are solitary, in radial rows of 2-4 or disposed in larger single or multiple rows tapering in shape, or several contiguous in the tangential plane, or in small nests, frequently with contiguous rays on one or both sides. The vessels are occasionally occluded with tyloses filled with starch grains. The greater mass of the wood is fibres and parenchyma. Wood rays, usually uni-, rarely biseriata, packed with starch grains and orange brown contents, traverse the woody cylinder. No pith could be distinguished.

(To be continued)



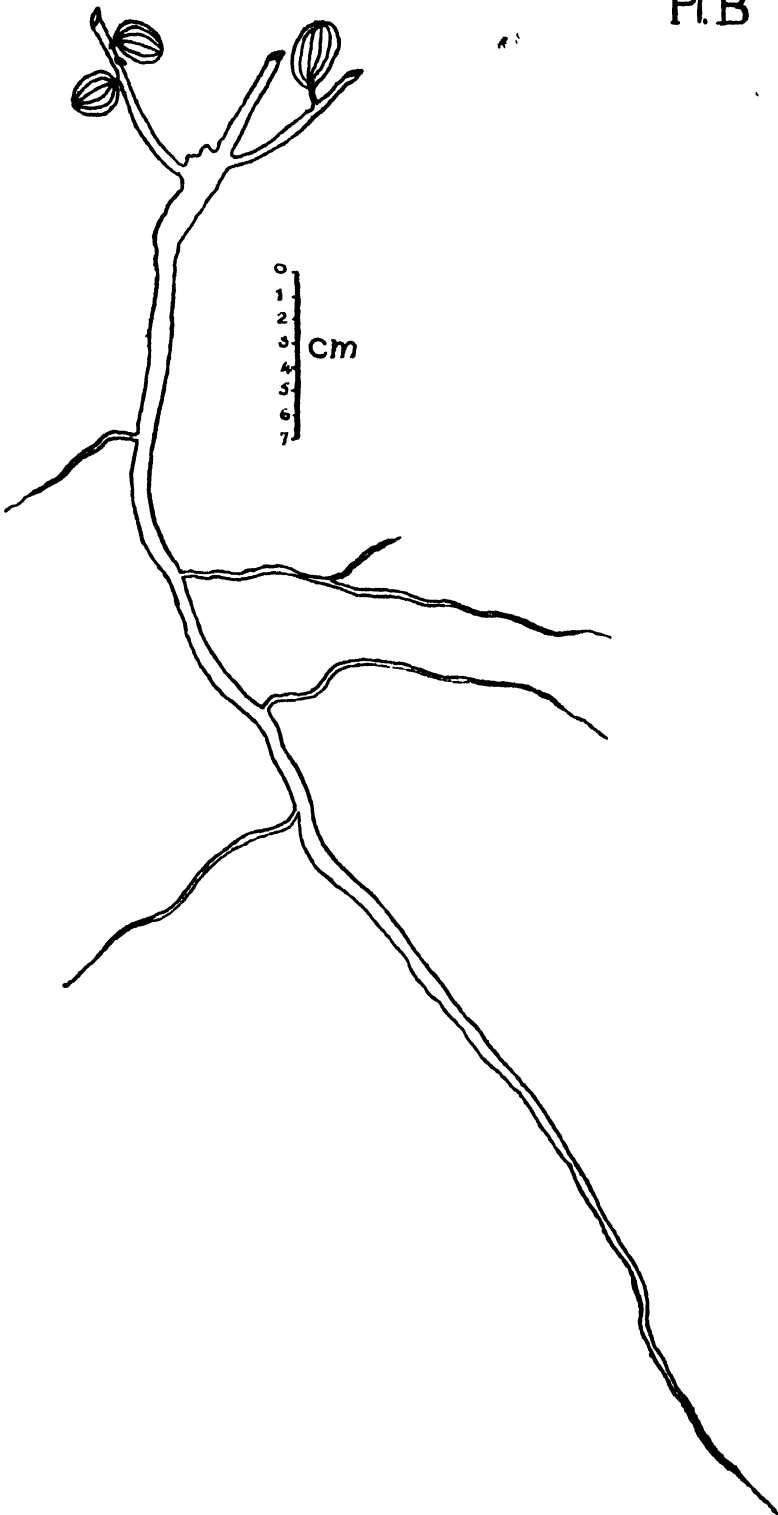
N.B.—Habit drawings of the roots of most trees have been taken from very young plants.

Root habit of *Phoenix sylvestris* Roxb.

Fig. 1.—Vertical section (diagrammatic) of basal portion of trunk: (a) of young plant; (b) of slightly older plant; and (c) of very old plant. Explanation in text.

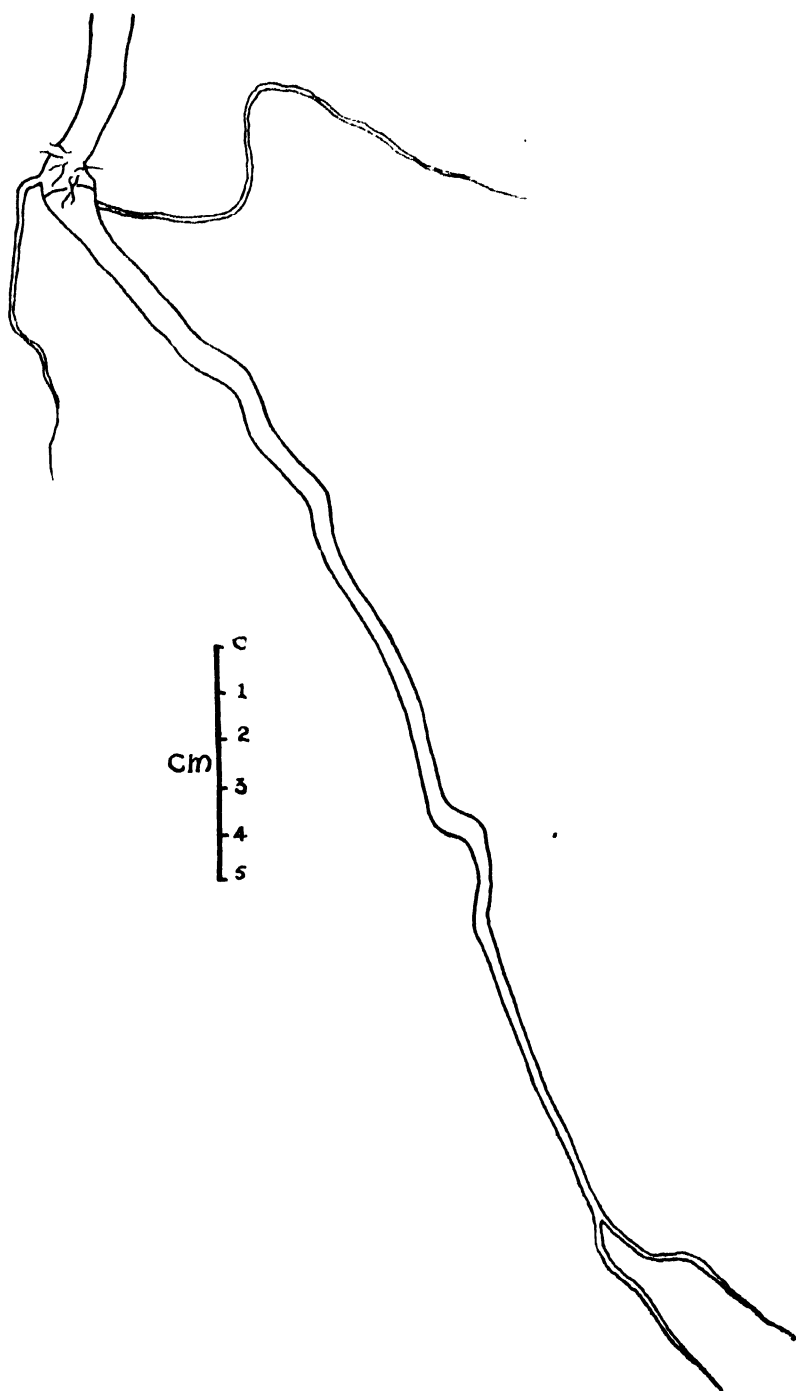
Fig. 2.—Diagram of stout adventitious root with its branches. Explanation in text.

Pl. B

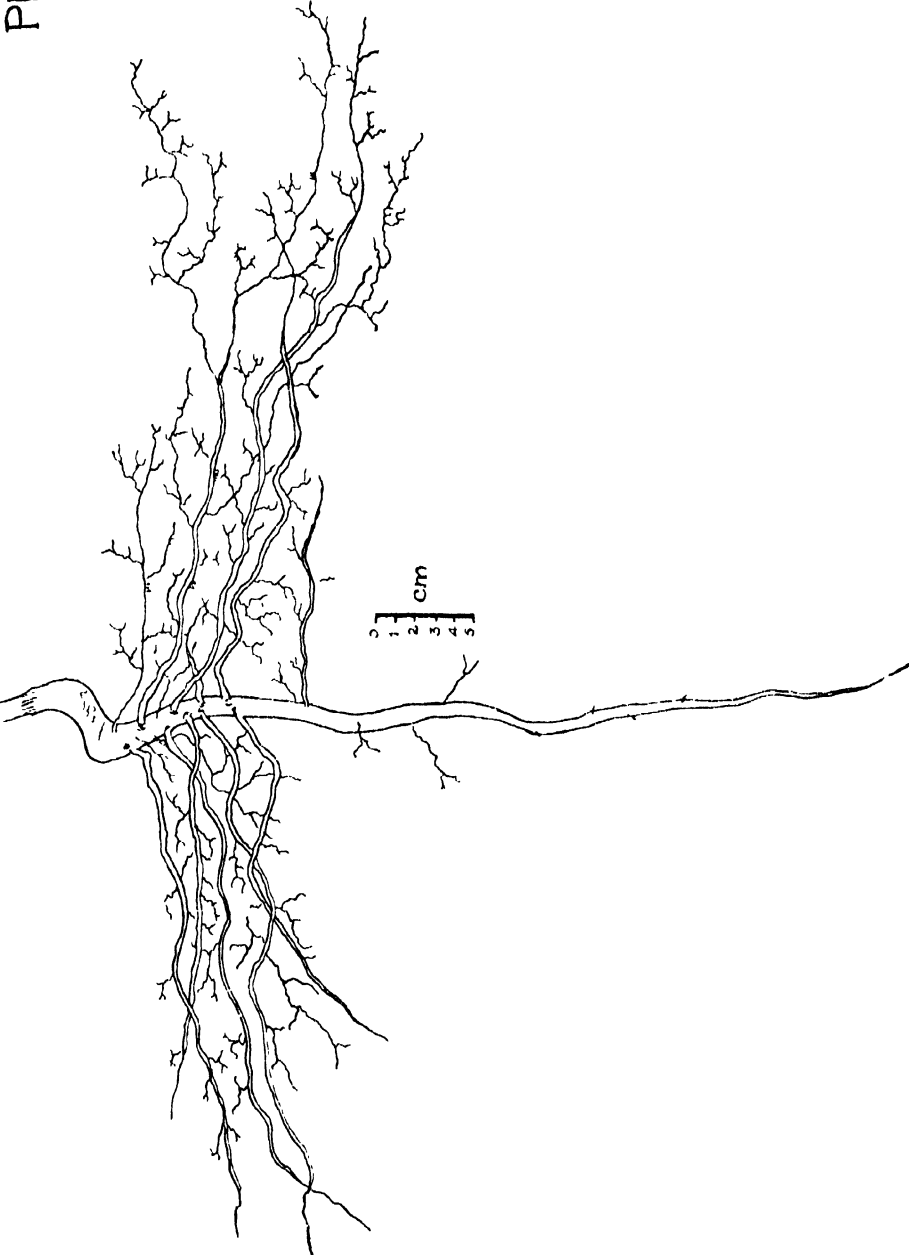


Root habit of *Zizyphus Jujuba* Lamk.

Pl. C

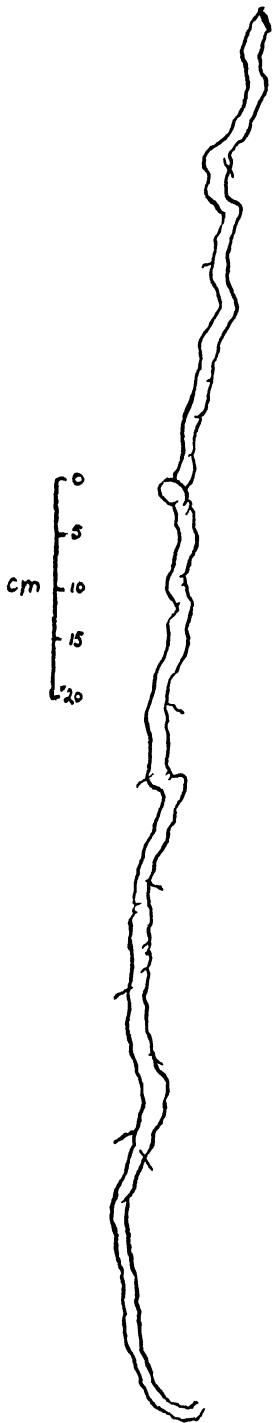
Root habit of *Anacardium occidentale* Linn.

Pl. D



Root habit of *Mangifera indica* Linn.

Pl E



Root habit of *Buchanania Lanzan Spreng.*



Phoenix sylvestris Roxb

I. Root habit of a young plant.



II.- Basal portion of the trunk invested by adventitious roots.
The scale in front is 1 metre.



III.—T. S. of the root of a seedling.



IV.—T. S. of a vigorous adventitious root (aerial) showing the stellar portion.

V.—T. S. of a vigorous adventitious root (underground) showing the net-like multiperforate plates in a vessel segment.



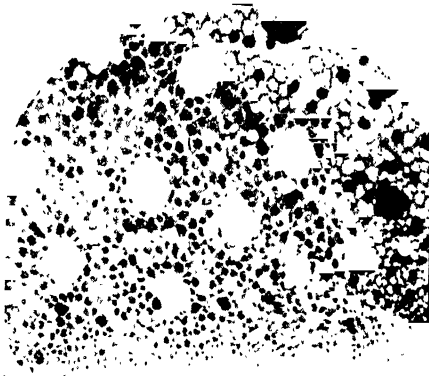
VI.—T. S. of a vigorous adventitious root (underground) showing the net-like multiperforate plates in a vessel segment.



VII.—T. S. of a thin slender acrotropic root (peripheral portion).



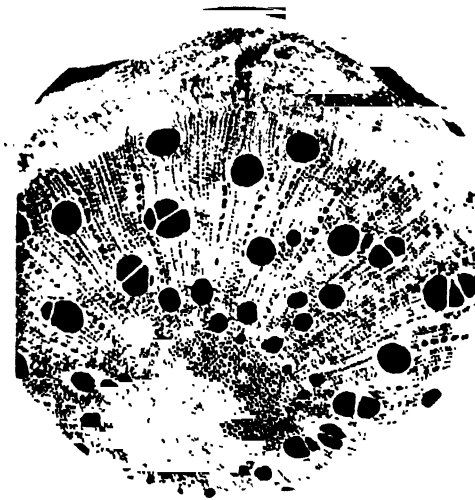
VIII.—T. S. of a thin slender branch root entering the soil (peripheral portion).





Anacardium occidentale Linn.

IX.- T. S. of the root.



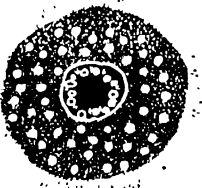
Mangifera indica Linn.

X.- T. S. of the root.

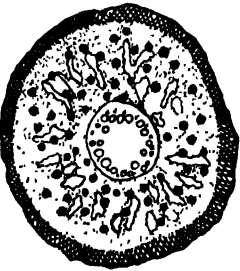
(Photos : H. Santapau)



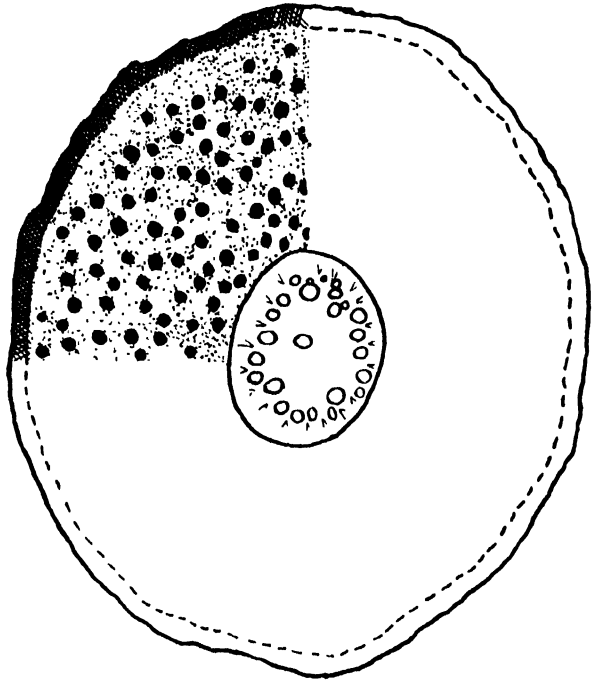
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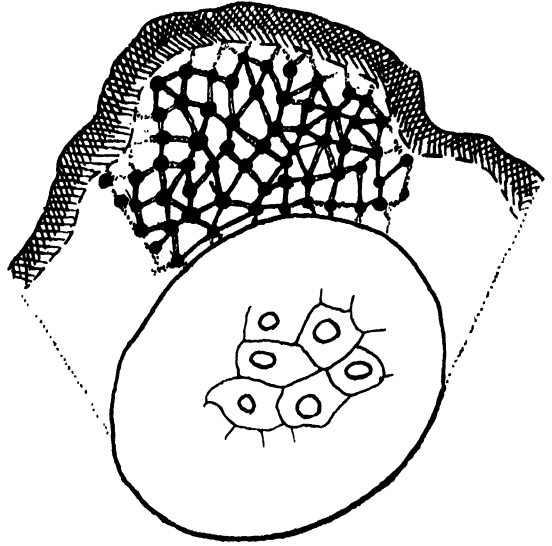
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5

***Phoenix sylvestris* Roxb.**

Fig. 3.—T. S. (diagrammatic) of adventitious root of seedling. The hypodermis is hatched; the ground tissue shaded with dots; fibrous bundles black; lacunae unshaded spaces in the cortex; vessels unshaded in stele. (x 8).

Fig. 4.—T. S. (diagrammatic) of vigorous adventitious root. Shading as in Fig. 3. (x 8).

Fig. 5.—T. S. (diagrammatic) of vigorous adventitious root. (Underground). Shading as in Fig. 3. (x 8).

Fig. 6.—T. S. (diagrammatic) of thin, slender aerotropic root. Shading as in Fig. 3. (x 8).

Fig. 7.—T. S. (diagrammatic) of underground portion of the thin slender branch root coming off from the vigorous root and entering the soil. Shading as in Fig. 3. (x 8).

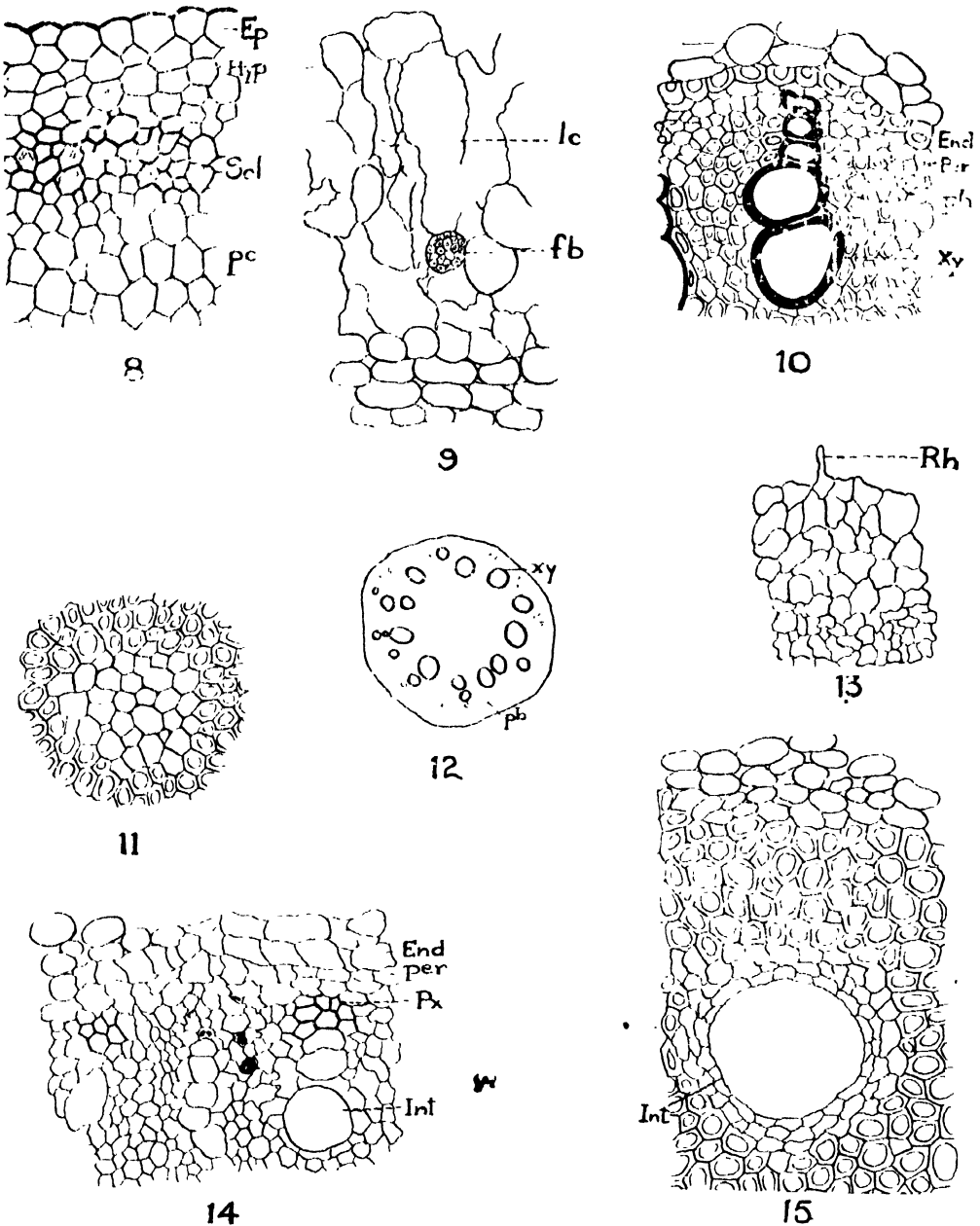


Fig. 8.—Portion of the T. S. of the adventitious root of the seedling : *Ep*, epidermis or outermost layer ; *Hyp*, hypodermis ; *Scl*, sclerenchymatous zone ; *Pc*, parenchymatous cortex. (x 225).

Fig. 9.—Portion of the T. S. of the adventitious root of the seedling : *lc*, inner lacunar cortex ; *fb*, fibrous bundle. (x 225).

Fig. 10.—Portion of the T. S. of the adventitious root of the seedling : *End*, endodermis ; *per*, pericycle ; *xy*, xylem ; *ph*, phloem. (x 225).

Fig. 11.—Central portion of the T. S. of the adventitious root of the seedling : *p*, pith surrounded by sclerenchymatous conjunctive tissue. (x 225).

Fig. 12.—T. S. (diagrammatic) of the adventitious root of the seedling showing the disposition of the vascular groups : *xy*, xylem ; *ph*, phloem. (x 40).

Fig. 13.—Portion of the T. S. of the vigorous adventitious root (aerial) : *Rh* root hair. (x 225).

Fig. 14.—Portion of the T. S. of the vigorous adventitious root (aerial) : *End*, endodermis ; *per*, pericycle ; *Px*, primary xylem elements ; *Int*, internal vessel. (x 225).

Fig. 15.—T. S. of stelar portion of the vigorous adventitious root (aerial) : *Int*, internal vessel surrounded by thinwalled unligified parenchyma outside which is thickwalled lignified conjunctive tissue. (x 225).

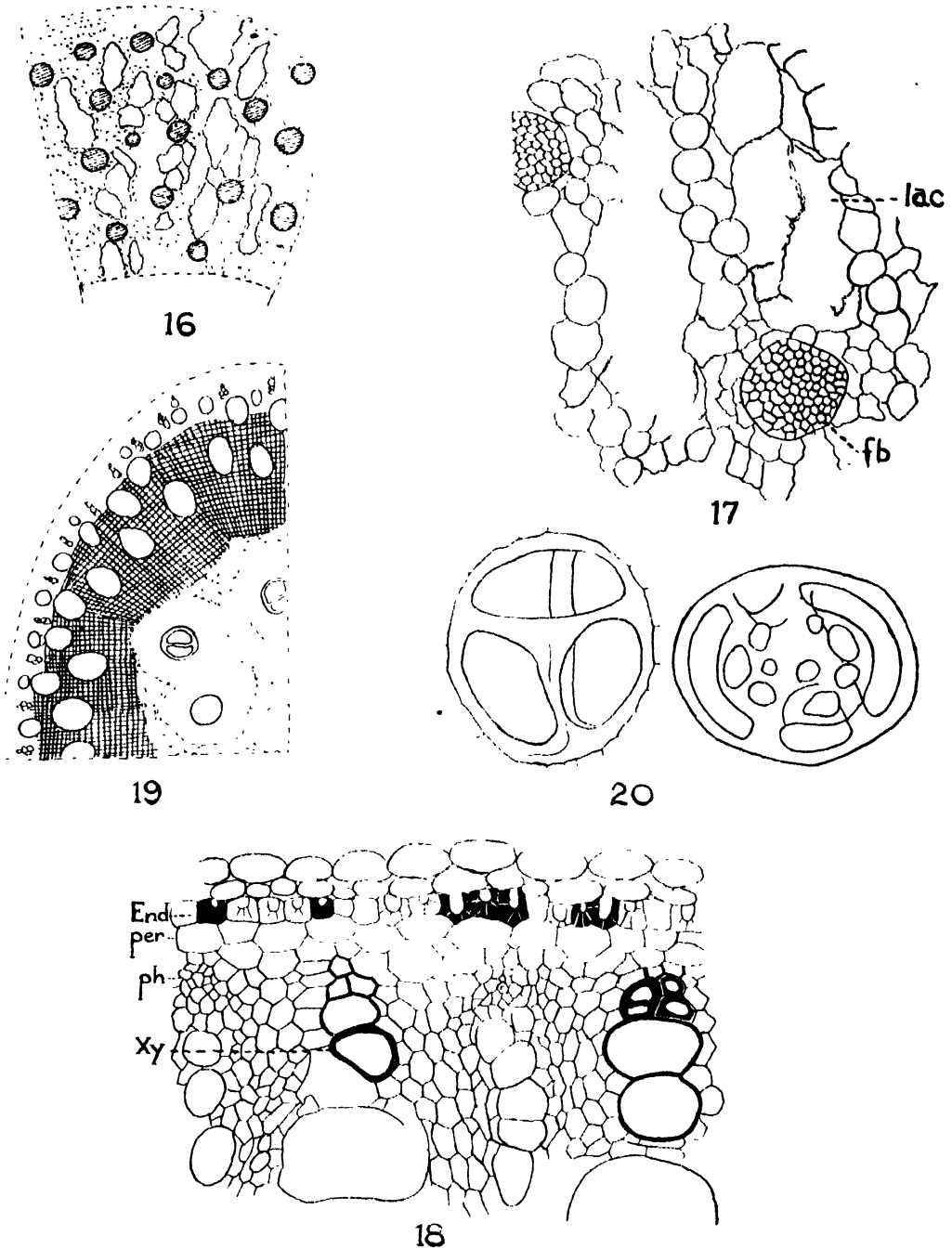


Fig. 16.—T. S. (diagrammatic) of the vigorous adventitious root (underground), showing concentric arrangement of the fibrous bundles in the lacunar cortex. Fibrous bundles hatched; cortex shaded with dots. (x 25).

Fig. 17.—Portion of the T. S. of the vigorous adventitious root (underground): *lac*, lacunae in cortex; *fb*, fibrous bundles. (x 112).

Fig. 18.—Portion of the T. S. of the vigorous adventitious root (underground): *End*, endodermis with branched canals; *per*, pericycle; *Xy*, xylem; *ph*, phloem. (x 225).

Fig. 19.—T. S. (diagrammatic) of the stelar portion of the vigorous adventitious root (underground) showing the disposition of the vessels: sclerosed conjunctive tissue is cross-hatched; parenchyma, shaded with dots; vessels unshaded. (x 25).

Fig. 20.—T. S. showing multiperforate plates in vessels (greatly enlarged). (x 225).

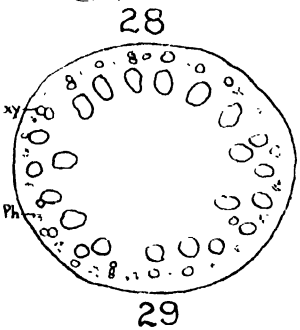
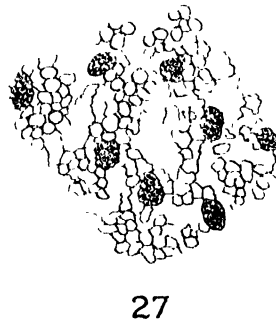
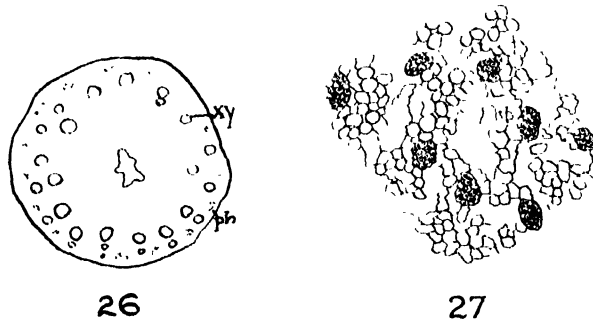
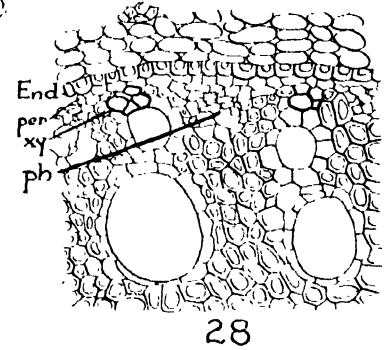
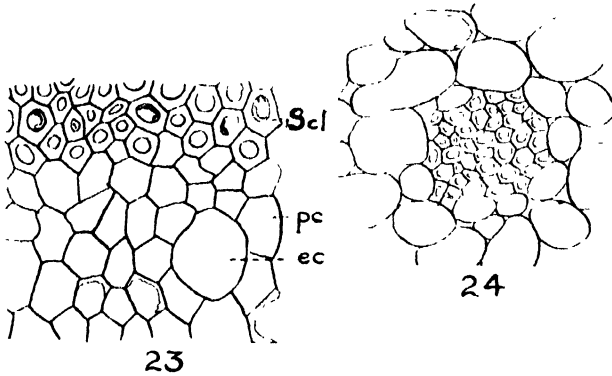
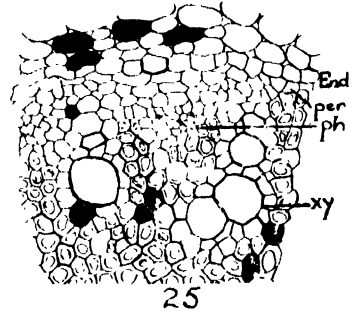
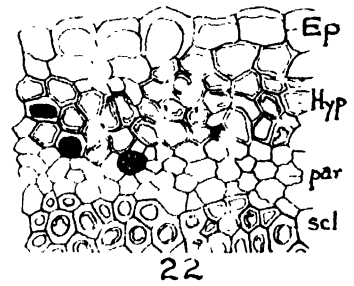
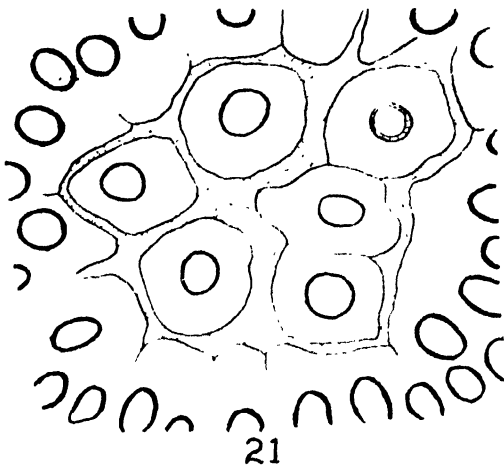


Fig. 21.—T. S. (diagrammatic) of the vigorous adventitious root (underground) showing isolated central vessels with accompanying thickwalled conjunctive tissue (cross hatched) ; parenchyma (shaded with dots). (x 25).

Fig. 22.—Portion of the T. S. of thin, slender aerenchymatous root : *Ep*, epidermis ; *Hyp*, hypodermis ; *par*, parenchyma ; *scl*, sclerenchymatous zone. (x 180).

Fig. 23.—Portion of the T. S. of thin, slender aerenchymatous root : *Scl*, sclerenchyma in part ; *pc*, outer parenchymatous cortex ; *ec* excretion cell. (x 180).

Fig. 24.—Portion of the T. S. of thin, slender aerenchymatous root showing single fibrous bundle in cortex. (x 180).

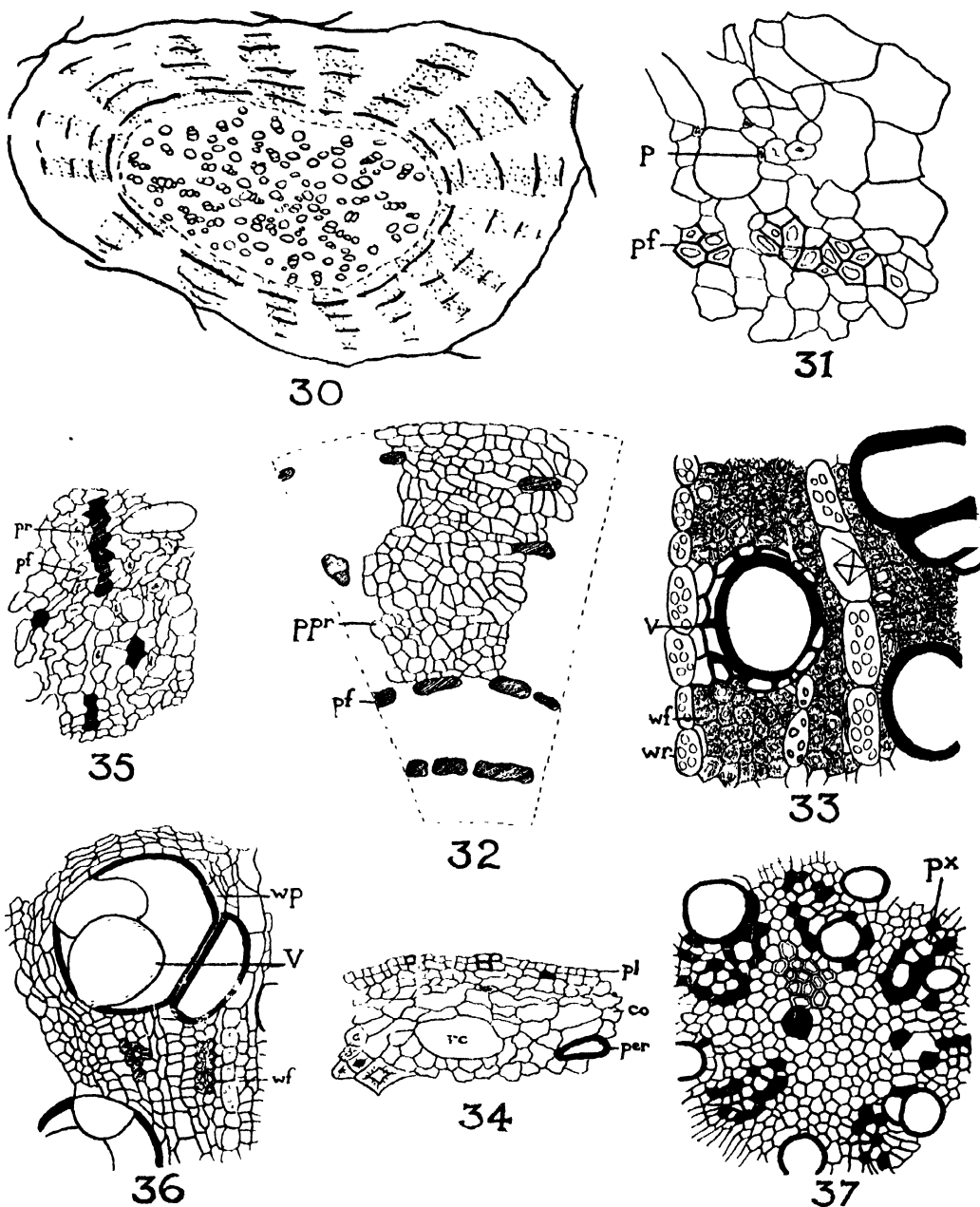
Fig. 25.—Portion of the T. S. of thin, slender aerenchymatous root : *End*, endodermis ; *per*, pericycle ; *xy*, xylem ; *ph*, phloem. (x 180).

Fig. 26.—T. S. (diagrammatic) the stele of thin, slender aerenchymatous root showing the disposition of the vascular groups : *xy*, xylem ; *ph*, phloem. (x 50).

Fig. 27.—Portion of the T. S. of the slender branch root entering the soil : *fb*, fibrous bundle ; *lac*, lacunae. (x 180).

Fig. 28.—Portion of the T. S. of the slender branch root entering the soil : *End*, endodermis ; *per*, pericycle ; *xy*, xylem ; *ph*, phloem. (x 180).

Fig. 29.—T. S. (diagrammatic) of the stele of the slender branch root entering the soil : showing the disposition of the vascular groups : *xy*, xylem ; *ph*, phloem. (x 40).



Zizyphus Jujuba Lamk.

Fig. 30.—T. S. (diagrammatic) of the root showing central woody cylinder surrounded by phloem consisting of phloem fibre strands (black bands) alternating with soft phloem (dotted). Thin corky flakes are seen at the periphery. (x 8).

Fig. 31.—Portion of the T. S. of the root : *p*, soft phloem tissue elements ; *pf*, phloem fibres. (x 225).

Fig. 32.—T. S. (diagrammatic) of the root showing concentric arrangement of phloem fibres (*pf*) and phloem parenchyma (*ppr*) in an active state of division. (x 25).

Fig. 33.—T. S. of the root showing close up of wood : *V*, vessel with halo of parenchyma ; *wf*, mucilaginous wood fibres ; *wr*, wood rays. (x 225).

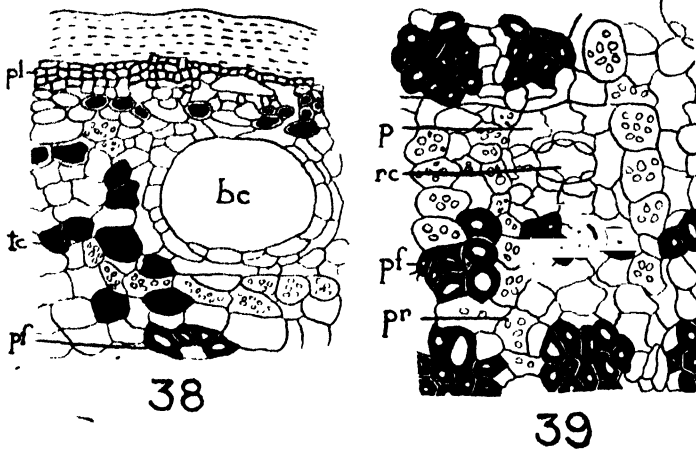
Anacardium occidentale Linn.

Fig. 34.—Portion of the T. S. of the root : *pl*, phelllem ; *per*, stone cells ; *rc*, resin canals ; *co*, cortical parenchyma. (x 112).

Fig. 35.—Portion of the T. S. of the root : *ip*, inner phloem ; *pf*, phloem fibre ; *pr*, phloem rays blocked with contents (black). (x 112).

Fig. 36.—T. S. of the root showing close up of wood : *V*, vessel with tyloses ; *wp*, wood parenchyma ; *wf*, wood fibres (mucilaginous). (x 225).

Fig. 37.—T. S. of the central portion of the root showing disposition of the primary xylem groups (*px*) surrounded by a lignified pith. (x 225).



Buchananiania Lanza Spreng.

Fig. 38. —Portion of the T. S. of the root showing : *pl*, phellem with outer phloem with wide balsam canal (*bc*) ; *pf*, phloem fibres ; *tc*, cells with brown contents. (x 112).

Fig. 39. —Portion of the T. S. of the root showing the disposition of the phloem tissue elements : *pf*, phloem fibres ; *p*, sieve tissue elements and phloem parenchyma ; *rc*, resin canals ; *pr*, phloem rays. (x 180).

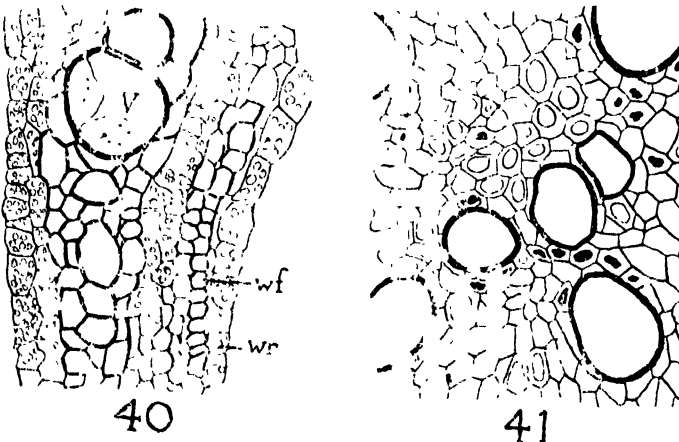


Fig. 40. —T. S. of the root showing close up of wood : *V*, vessel in multiple row, *wf*, wood fibres ; *wr*, woods rays. (x 112).

Fig. 41. —T. S. of the root (central portion) showing disposition of the primary xylem groups. (x 225).

LIST OF THESES

List of Theses in Botany, Zoology, Microbiology, Agriculture, Agricultural Botany which have been accepted in lieu of the Examination for the Degree of M.Sc., Ph.D. and D.Sc. (from October 1947 to September 1948)

Name of the Candidate	Title of Thesis	Teacher	Place of Research
M.Sc.			
<i>Botany</i>			
Dubash, P. J.	Studies of Nitrophilous Plant Associations	Dr. F. R. Bharucha	R. I. Sc.
Gangla, K. S. (Miss)	The Algae of Cultivated Soils	Mrs. E. Gonzalves	R. I. Sc.
Hingorani, G. R.	Embryological Studies in Vitis Frifolia L.	Dr. B. N. Mulay	D. J. S.
Karnik, C. R.	Ecological Studies of the Weed Flora of the Rice Fields	Dr. F. R. Bharucha	R. I. Sc.
Khansaheb, N. J. (Miss)	A Contribution to the Studies of the Anatomy of the Indian Cucurbitaceae	Professor J. F. R. d'Almeida	St. X.
Mavalwalla, H. C. (Miss)	Primary and Secondary Extrastelar Formations in Plants	Professor J. F. R. d'Almeida	St. X.
Shah, G. L.	Floral Organogeny and Embryology of Coriandrum Sativum Linn.	Dr. R. D. Adatia	W.
<i>Zoology</i>			
Bapat, S. V.	The Food of Fishes	Dr. D. V. Bal	R. I. Sc.
Dubale, M. S.	A Comparative Study of the Extent of Gill-surface in some representative Indian Fishes and its bearing on the Origin of the air-breathing habit	Dr. C. J. George	W.
Khambatta, F. S.	Cestodes of Marine Fishes of Bombay	Dr. D. V. Bal	R. I. Sc.
Munshi, D. M.	Anatomy and Bionomics of Ctenocephallus felis (Boncha)	Professor K. R. Karandikar	R. I. Sc.
Uttangi, J. C.	Infusorian Parasites of Anurans of Karnatak	Professor P. W. Gideon	K. C.
Redkar, M. V., (Miss)	Copepod Parasites of Fishes	Dr. N. M. Murti	R. R.
<i>Microbiology</i>			
Holenarasipur Laxminarayana	Studies in the Bacteriological Quality of Indian Milks with special reference to Resazurin Test	Worked Independently	I.D.R.I.

Name of the Candidate	Title of Thesis	Teacher	Place of Research
	<i>Agriculture</i>		
Parikh, R. G.	Food Crops of Gujarat	Mr. M. L. Dantwala	U. E. S.
Karnani, B. T.	Investigation of Vegetable Milks	Professor V. Subrahmanyam	I. I. Sc.
	<i>Agricultural Botany</i>		
Munshi, Z. A.	Inheritance of Certain Characters in Sorghum	Mr. G. B. Patel	Agri. Research Stn. Surat
	Ph.D.		
	<i>Botany</i>		
Solomon, S.	The Physiology of Phanerogamic Parasitism with special reference to <i>Striga Lutea</i> Lour and <i>S. densiflora</i> Benth on <i>Andropogon Sorghum</i> Hack.	Professor L. S. S. Kumar	C. Ag.
	<i>Zoology</i>		
George, Caleekal John	Studies in Vertebrate Evolution in Relation to the Environment	Dr. C. J. George	W.
Varde, M. R. (Miss)	A Comparative Study of the Anatomy of Some Indian Snakes with notes on certain histological and Physiological Features	Professor C. J. George	W.
	<i>Agriculture</i>		
Lu Hao Jan	Heterosis in Crop Plants	Dr. B. P. Pal	I.A.R.I.
	D.Sc.		
	<i>Zoology</i>		
Sen, S. K.	Studies in Insects, Ticks and Mites being a Collection of published paper in Zoology		

BOOKS RECEIVED

Harlem Hospital Bulletin, the—, Vol. 1, No. 1, June 1948.

Index-Catalogue of Medical and Veterinary Zoology, Part 10. Authors: M. to Mysh. United States Department of Agriculture.

Preliminary Survey of Biological Research in Quebec, by James Kucynaik. Montreal, Canada.

Publications of the Chicago Natural History Museum—

Bacula of Some Fruit Bats, (Pteropus), the—, by D. D. Davis, Vol. 31, No. 16.

Catalogue of North American Beetles of the Family Cleridae, by Albert B. Wolkott, Vol. 32, No. 2.

Catalogue of Type Specimens of Fishes in Chicago Natural History Museum, by Marion Grey, Vol. 32, No. 3.

Geographical Races of the Rodent *Akodon Jelskii* Thomas, by C. C. Sanborn, Vol. 31, No. 17.

Malleus (Ossiculum Auditus) of the Anthropoid Apes, the—, by W. Segall, Vol. 31, No. 14.

New Kinosternid Turtle from Columbia, a—, by Karl P. Schmidt, Vol. 31, No. 13.

New Race of Koklas Pheasant, a—, by R. L. Fleming, Vol. 31, No. 11.

Notes on Amphibians and Reptiles of Michoacan, Mexico. by Karl P. Schmidt and F. A. Shalmon, Vol. 31, No. 9.

Notes on Phillippine Mosquitoes—XI. A New Species of *Tripteroides*, by F. E. Baisas, Vol. 31, No. 15.

Phalangida from Tropical America, by Clarence J. and Marie L. Goodnight, Vol. 32, No. 1.

Some Neuropterous Insects from Szechwan, China, by Nathan Banks, Vol. 31, No. 12.

Two Races of the Bridled Tilmouse, by A. J. Van Rossem, Vol. 31, No. 10.

Publications of the Council for Scientific and Industrial Research of the Commonwealth of Australia

Ecological Observations on the Small Plague Grasshopper *Austroicetes Crucata* (Sauss) in the Trangie District, Central Western New South Wales, by L. R. Clark, Bulletin No. 228.

Econological Study of the Australian Plague Locust (*Chortoicetes Terminifera* Walk) in the Bogan-Macquarie Outbreak Area, N. S. W., an—, by L. R. Clark, Bulletin No. 226.

Examination of the Peet-Grady Method for the Evaluation of Household Fly Sprays, and—, by D. F. Waterhouse, Bulletin No. 216.

Laboratory and Field Tests of Mosquito Repellents, by R. N. McCulloch and Waterhouse, Bulletin No. 213.

Spray Tests Against Adult Mosquitoes, by D. F. Waterhouse and D. O. Atherton, Bulletin No. 219.

Studies in the Biology of the Skin and Fleece of Sheep, by H. B. Carter and Margaret H. Hardy, Bulletin No. 215.

Studies in Perennial Veldt Grass, by R. C. Rossiter, Bulletin No. 227.

Publications of the Indian Central Cotton Committee—

Diseases of Cotton in India, by B. N. Uppal.

Insect Pests of Cotton in India, by H. D. Nangpal.

ACKNOWLEDGMENTS

Discovery

Ingenieria Quimica

Journal of the Chemical Society, London

Journal of the India Society of Engineers

Main Currents in Modern Thought

Manufacturing Chemist

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PART 4

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HISTORY OF KARNATAK—A BRIEF SURVEY

BY VIDYARATNA R. S. PANCHAMUKHI, M.A.,

Director of Kannada Research, Dharwar

- (i) Karnatak in the Pre-historic period.
- (ii) The Geographical extent of the Kannada-speaking area : ancient and modern.
- (iii) Four periods of Karnatak history.
- (iv) Karnatak under the Mauryas and Andhras.
- (v) Kadambas the first Kannada dynasty.
- (vi) The first Kannada Empire under the Chalukyas of Badami.
- (vii) Karnatak under the Rāshtrakūṭas and Gaṅgas.
- (viii) Gujarat and Āndhradesa under the kings of Karnatak for over 500 years.
- (ix) Expansion of the Karnatak influence under the Chalukyas of Kalyāṇi.
- (x) Rise of the feudatory chiefs the Kaḷachurya, Yādava, Hoysala as independent monarchs.
- (xi) Mohammadan invasion under Malik Kafur and the rise of the Hindu power of Vijayanagara.
- (xii) Fall of Vijayanagara and the rise of the Maratha power to check the Mohammadan aggression ; part played by the potentates of Karnatak.
- (xiii) Conclusion : Salient features of Karnatak history.

THE History of Karnatak presents a glorious picture of the achievements of man in all fields of activity. In political institutions, administrative machinery, empire-building, religious and spiritual career, art and architecture, Literature and other fine arts as well as in cultural integrity, Karnatak held a unique place of honour among the sub-nations of India and has made a solid contribution to the purity and greatness of Indian culture. A brief account of the contribution of Karnatak in the various branches mentioned above is given in the following birds' eye-view of the history of Karnatak from the earliest period down to the present age.

(i) The geographical factor has moulded the history of Karnatak to an advantage which has lent an unsurpassable *fillip* to the expression of the latent powers of human mind and body. The Dekkan plateau in the centre of which Karnatak is situated, is one of the oldest spots on earth where human life first appeared. One is expected accordingly, to unearth cultural remains of the highest antiquity buried up in the debris and mounds, that will be informative of the life of man lived in the hoary antiquity when civilization had not yet introduced the instruments of advanced social and scientific contacts. In the pre-historic age, the culture represented by the finds unearthed at Herakal

(Bijapur District) Chandravalli (Mysore), Maski (Hyderabad) etc., is assessed to be of a high type comparable to that of any part of India and it is suggested that in the early period prior to the Mauryan rule in the 3rd century B.C., Karnatak had established a commercial and cultural intercourse with the Western and Eastern nations that held the custody of human progress.

(ii) Karnatak was in the ancient period, conterminous with the country where Kannada was the spoken Language. From a study of the find-spots of the Kannada Inscriptions known to exist and from the evidence of literary statements, it is found that Kannada Language was current in the area, at least in and from the 9th century A.D., bounded on the North by the Gōdāvarī, on the East by the Veṅgi-Vishaya (Guntur and Krishna Districts roughly) of the Eastern Chalukyas, on the South by the Kāvēri river and on the West by the Arabian Sea adjoining the strip of Konkan. The Northern and Eastern limits have in the course of centuries been pulled down to the Bhīmā on the North and to the Kurnool and Anantapur Districts on the East. Similarly the Southern boundary has been pushed up. But, for the present survey, the Geographical extent between the Gōdāvarī and the Kaveri is taken to comprise the ancient Karnatak where several royal households rose and made solid contribution to the greatness of Karnatak culture.

(iii) The history of Karnatak may be divided roughly under four periods, viz (I) Ancient period (1) Mauryan : 3rd century B.C. (2) Āndhras or Sātavāhana (1st to 3rd century A.D.), (3) Kadamba (4th century to 6th century A.D.) ; (II) (1) Early Chalukya (6th century A.D. to 8th century A.D.) and (2) Rāshtrakūtas (8th century A.D. to 10th century A.D.), with the great feudatory power the Gaṅgas in Mysore (3) Later Chalukyas of Kalyāṇi (10th century A.D. to 12th century A.D.) ; (III) Mediaeval period (1) The Kaḷachuryas; (2) The Yādavas of Devagiri (12th century A.D. to 14th century A.D.) and (3) The Hoysalas of Dōrasamudra (12th century A.D. to 14th century A.D.) ; (IV) Early Modern period ; the Vijayanagara dynasties (14th century A.D. to 16th century A.D.). It may however, be observed that the history of a nation is not merely a record of the exploits or achievements of a royal family but is a complete account of the basic life-currents that express themselves in various forms in the activities of the kings and people of the contemporary period. With this underlying idea, the above division has been made, but the dynastic names have been adopted merely to distinguish one period from the other, chronologically.

(iv) The Mauryan sway over Karnatak is evidenced by the edicts of Aśōka discovered at Kopbal, Maski, Siddapur, Jaṭiṅga-Rāmēśvar and Brahmagiri. The Siddapur edicts were addressed to the officials at Isila by the Ayaputa (Āryaputra) and Mahamata (Mahāmātra) at Suvarṇagiri, which shows that Isila with its surrounding region near Siddapur, the find-spot of the edict, was included in the Mauryan empire. Suvarṇagiri is supposed to be the Mauryan capital of the Deccan during the reign of Aśōka. The traces of the Maurya occupation of the Deccan and Karnatak can be seen in the tradition about the pigmy houses i.e. dolmens being called *Mōrēra-aṅgaḍi* i.e. shops or dwellings of the Mauryas, and the Maurya chieftains holding a territory in Konkan who were subjected by Pulikēsin II in the 7th century A. D. After the

Mauryas, the Karnatak was held by the Āndhras, their semi-independent feudatory rulers of the Sātāhani-hāra or Sātāhani-Raṭṭha, modern Bellary Dist. The Āndhras ruled over a vast territory from the Gōdāvari on the North to the Pennar in the South. The Makedoni inscription of Puḷumāvi II refers to Sātāhani-hāra which is found mentioned in the Hirehaḍagali plates of Pallava Sivaskandavarman, under the form *Sātāhani-raṭṭha*. This suggests that the southern portion of the Āndhra kingdom i.e. the Bellary District etc., passed to the Pallavas who succeeded the Andhras in a portion of their territory. The Pallava hold did not continue long, in Karnatak. From the Taḷgunda inscription of Kadamba Śāntivarman, it is learnt that Mayūraśarma the Kadamba ancestor wrested from the Pallavas the Śrīśaila region and held practically an independent sway in a country bounded on the West by the sea and on the East by Prēhāra (?). The record narrates a thrilling account of how a Brahmin youth who had come to the Ghaṭikāsthāna of Kāñchi to prosecute his further studies, found an occasion to carve out a new kingdom finally acknowledging, though nominally, the power of the Pallavas. The Chandravalli inscription of this Mayūraśarma records the brilliant successes of the king over Trekuṭa, Ābhira, Pallava, Pariyātraka. Śaka-sthāna, Sayindaka, Punnāṭa and Mokari. With the rise of the Kadamba Mayuravarman begins the political career of Karnatak which in the course of the centuries, grew a strong power to be reckoned with and became ultimately the meeting ground of all nationalities and races during the Vijayanagara period i.e. between the 14th and 16th century A. D.

(v) The Kadambas had contracted matrimonial alliances with the first-rate political powers of India viz., the Guptas of Pāṭaliputra in the North, the Vākāṭakas of Central India and the Gaṅgas of Talakad in the South. They remained till the end, the inveterate foes of the Pallavas of Kanchi whose yoke they shook off under Mayūraśarma. They patronised both the Vaidika and Jaina worship and encouraged the cultivation of fine arts. The poets Samantabhadra, Paramēśhṭhi, Sivakumāra-Māndhātri, patron of Kundakundāchārya the author of *Prābhṛitasāra* etc., are supposed to have flourished during the Kadamba rule in Karnatak. The last prince of the family was Harivarman during whose time the kingdom passed to the Chalukyas of Badami who apparently were holding a subordinate position under Harivarman.

(vi) The first genuine record of Pulikēsin I the founder of the Chalukya kingdom hails from Badami and records the construction of the Vātāpi-durga (Badami Fort) in Śaka 465. His grandson Pulikēsin II was the most powerful king of the family who carried a campaign of conquests throughout the Dekkan and South India and defeated Paramēśvara Harshavardhana of Kanauj, on the banks of the Narmadā. He was the first Karnatak sovereign to establish an empire south of the Vindhya and proclaimed himself the sole lord of the entire Dekkan and Karnatak including the Telugu country. Huiyen Tsiang the Chinese pilgrim visited his court in about 640 and recorded the glory of Karnatak and the Kannada people during his reign. Pulikesi II had received Persian embassy and exchanged letters with the king of Persia. He appointed his brothers and sons in the newly conquered territory as Viceroys, keeping to himself the original kingdom in the Western Dekkan which is conterminous with the ancient Karnatak comprised in the three Mahā-

rāshtrakas of the Aihole inscription of A. D. 634. His brother Kubja Vishṇuvardhana held charge of the Āndhradēśa and became the founder of the Eastern Chalukya family in Vengidēśa.

Pulikesin II scared away the powerful Pallava monarchs Mahēndravarmaṇ and Narasimhavarmaṇ. The latter prince with a confederacy of the Chōḷa, Pāṇḍya and Kēraḷa is said to have occupied the Chalukya kingdom for about 12 years ; but he was ousted from Badami by Vikramāditya I, son of Pulikēsin II, who recovered the lost glory of his family by driving out the foreign hand and consolidating his own power with the aid of the feudatory chiefs the Gaṅgas and his son and grandson Vinayāditya and Vijayāditya respectively. Vijayāditya's son Vikramāditya II carried his arms to the Pallava capital Kāñchi and "captured Kāñchi and inspected the riches of the Rājasimhēśvara temple, gave them again to the God" (*Kāñchiyān koṇḍu Rājasimhēśvarada dhanamān=kaṇḍu maguḷḍu devaragge biṭṭār*). During the Chalukya Sovereignty, Karnatak had become a power to be reckoned with by the contemporary rulers of India and foreign nations. Her contribution to the cultural greatness and integrity of India is of varied magnitude and character. The Chalukya court patronised the renowned poets of their age viz., Dāmōdara, Bhāravi and Ravikīrti the last of whom is extolled in the Aihole inscriptions as "inspired in poetry by Kālidāsa—and Bhāravi (*kavitāśrita Kālidāsa-Bhāravi kīrttiḥ*)".

The Gaṅgas of Taḷakāḍu continued to be the vassals of the Chalukyas and were like their masters patrons of learning and culture. Durvīṇa was the author of a commentary on the 15th canto (or 15 cantos) of Bhāravi's *Kirā āṛjunīya* and of a grammatical work called *Śabdāvatāra*. He rendered into Sanskrit, Guṇāḍhya's *Vaḍḍakaho* in *Paiśāchi*.

The Chalukyas evolved a special style of architecture with the combination of the Northern vertical and the Dravidian or Pallava horizontal tiers of the *Gōpuras* and this ultimately became the originator of the late Hoysala style in which the temples of Bēlur, Halebid and Somanāthapur are worked out with elaborate details. The cave temples at Badami and the clusters of temples at Paṭṭadakal and Aihole erected by the Chalukyas, furnish the basic principles on which the sculptural and architectural styles of the Dekkan and Karnatak were produced. Just as the Guptas who succeeded the Mauryas and Kushāṇas of the Buddhist persuasion, were staunch votaries of the Vaidika and Paurāṇika religion and ushered in an age of renaissance in all fields of cultural activity, similarly the Chalukyas of Badami coming as they do after the Buddhist and Jain rule of the Āndhras (Sātavāhanas), the Chuṭus of the West coast and the Kadambas and Gangas of Jaina leanings, encouraged the study of Vedic lores, displayed the pauranik legends on temple walls and built numerous temples for Śiva and Vishnu of the Pauranik pantheon.

(vii) The 8th century A. D., saw the decline of the Chalukya power. The Rāshtrakūṭas who are referred to in earlier inscriptions as *Raṭṭgudi* *Raṭṭagudlu* or *Raṭṭas* rose to power under Dantidurga who crushed the *Kaṇṇa* army of the Chalukyas and occupied their territory. He was succeeded by his uncle Krishna I who is said to have "turned the Boar (of the Chalukyas) into a deer". Kṛishṇa I constructed the famous

Kailāsa temple at Ellora which is one of the wonders of the world. He nominated his second son Dhruva to the throne to the exclusion of his eldest son Gōvinda II who had acted as Yuvarāja. This brought about a fratricidal war in which the Gaṅga Śivamāra Saigoṭṭa and his son Mārasimha I sided with Govinda II. Dhruva was successful in the end. His son Gōvinda III ascended the throne in about A. D. 793. He carried extensive campaigns into North as well as South India. In his North Indian campaign, he defeated the invincible Gūrjara Pratihāra Nāgabhaṭa and the Pāla king Dharmapāla and proceeding northwards inscribed the letters "Victory" on the peaks of the Himalayas. In the South, the family-enemies the Pallavas were met on several battle-fields and were ultimately made to pay an annual tribute to the Rāshtrakūṭa sovereign at Malkhed. In a copperplate grant of A. D. 804, Gōvinda III is stated to have encamped at Rāmēśvara-tīrtha on the Tungabhadra with a view to the exacting of tribute from Pallava Dantiga i.e. Dantivarman. His commands were obeyed by the Eastern Chalukya king Vishṇuvardhana IV who was made to supervise the building of the rampart of the capital city Mānyakhēṭa.

Kamba or Stambha the elder brother of Gōvinda III had rebelled against the throne, with a confederacy of twelve princes. Govinda crushed the confederacy and showing mercy on his brother placed him in charge of *Gaṅgamaṇḍala*. After the fall of the Chalukyas, the Gangas could not reconcile with the new power and were always at war with the Rāshtrakūṭas until Amōghavarsha-Nṛpatuṅga made a shrewd move by giving his daughter Chandrobballabbe in marriage to Butuga I. This brought about cordial relations between the two families which were cemented by further matrimonial alliances.

Amōghavarsha succeeded his father Gōvinda III as a young prince in A. D. 814. He was helped in the administration of the country by his paternal cousin Karkarāja of Gujarat and a senior councillor Pātālamalla. His rule though disturbed during the first few years, was on the whole quiet and eventful. He patronised poets and philosophers and himself was an accomplished man of letters. His long reign (A. D. 814-878) of about 65 years witnessed the rise of Jinasēna, Guṇabhadra Śākaṭyāna, Kaviśvara (if he is different from Amōghavarsha himself author of *Kavirājamārga*) and Mahāvīrachārya author of *Gaṇitasangraha* etc. He is stated to have cut off his left finger and offered it to Mahālakshmi to avert some calamity to the people. ते ऽप्य कैकमतर्पयन् किलमहालक्ष्म्ये स वामांगुलिम् । लोकोयद्रव शांतय स्म दिशति श्री बीरनारायणः ॥

—Sanjan plates.

His piety and loyalty to Jaina faith induced him to abdicate the throne on many occasions (cf. *विवेकात्यक्र राज्येन* of his *प्रश्नोत्तर मालिका*). Amōghavarsha I was succeeded by his son Krishṇa II in A. D. 878 who ruled upto A. D. 912. The wars with the Gūrjara Pratihāras of Kanauj continued and Krishṇa II is stated in the Bagumra plates of his grandson Indrarāja, to have vanquished the Gūrjara monarch who was apparently Bhōja I grandson of Nāgabhaṭa. The most important event of his reign was to exterminate the race of the first Gujarat branch of the Rāshtrakūṭas who under Mahārājādhirāja Karkarāja had become the sole lords of the Lāṭamaṇḍala. Gōvinda III had ousted them from a part

of this *maṇḍala* and appointed his own brother Indrarāja III as Viceroy over it. It was during Kṛishṇa II's reign that they were driven out of the Lāṭadēśa and their country was annexed to the Rāshtrakūṭa dominion.

(viii) It may be noted in passing that Gujarat (Lāṭadēśa) was under the direct control of the rulers of Karnatak from the very early time. After his *digvijaya* campaign of A. D. 610-11, Pulikēsin II placed Lāṭamaṇḍala in charge of his brother Dhārāśraya Jayasimhavarman whose descendants held the Province until the rise of the Rāshtrakūṭa Dantidurga. Avanijanāśraya Pulikēśivarman of this Gujarat Chalukya branch was ruling over Lāṭadēśa contemporaneously with the Gujarat Rāshtrakūṭa king Mahārājādhirāja Karkarāja who must have subdued Avanijanāśraya Pulikēsi or his descendant and occupied the whole of Lāṭadēśa with Kheṭaka, in the middle of the 8th century A. D. (Circa 758). In his North Indian campaigns of cir. A. D. 804, Gōvinda III conquered the rulers of Lāṭa and made his brother Indra III the lord of Lāṭēśvaramaṇḍala. The members of the conquered Rāshtrakūṭa branch Karkarāja were finally driven out and subdued by Kṛishṇa II in about A. D. 880 and their territory annexed to the Rāshtrakūṭa empire. Kṛishṇa's Viceroy in Harshapuraprānta in Lāṭamaṇḍala was Mahāsāmanta Prachanda of Karnatak. After some time, this territory must have passed to the second Gujarat branch started by Indra III, which looked upon Karnatak as its home province. This continued till about the fall of the main Rāshtrakūṭa line when Paramāra Muṇja had occupied it. But, again, the country passed to Taila II who uprooted Muṇja in about A. D. 973. Soon after, Mūlarāja the ancestor of the Anhilwād Chaulukyas killed Bārappa the representative of Taila II in Gujarat and occupied Lāṭadēśa. During the subsequent period the destiny of Gujarat was tossed between the Paramāras, the Chaulukyas evidently the descendants of the Gujarat branch of the early Chalukyas of Badami and the Yādavas of Devagiri until the Hindu kingdoms were engulfed by the Mohemadan invasions from the North in the 12th century A. D. Thus, for about 5 centuries of years i.e. from the 7th to 12th century A. D. Gujarat owed its political security and cultural integrity to Karnatak which likewise fed the famished nerves of the Āndhradēśa (Telugu country) by implanting the Eastern Chalukya Dynasty on the soil of Vengi-maṇḍala in the 7th century A. D.

After Kṛishṇa II, his grandson Indra III occupied the Rāshtrakūṭa throne in about 912. The next powerful monarch of the family was Kṛishṇa III who ascended the throne in A. D. 939-40. He carried his arms far and wide and the Jura *Praśasti* engraved on a stone tablet at Jura in Maihra State in Central India recording his *birudas* and exploits in pure Kannada Language and alphabet, bears ample testimony to his North-Indian campaign of conquests. In the South, he killed the Chōḷa prince Rājāditya on the battle-field at Takkolam and made State entry into the Chōḷa country (*Toṇḍaimaṇḍalam*) with all pomp and paraphernalia and occupied it for a number of years. His reign is marked with astounding events both in the expansion of territory and the advancement of cultural arts. The Rāshtrakūṭa dominions extended during his reign to the Chēdi kingdom (Central India) in the North, Khēṭaka-maṇḍala (Gujarat) in the West, Toṇḍaimaṇḍalam (Tanjore province in the Madras Presidency) in the South and the Vengi-rājya (Guntur and Krishna Districts) in the East. This vast

territory was administered by him through the feudatory chiefs and viceroys employed under his command. His trusted servants were the Gaṅgas of Talakad whose king Butuga II had married his sister Rēvakanimmaḍi. Būtuga helped his brother-in-law both in the Northern and Southern expeditions and brought him vast treasures of war. It was, during the rule of his grandson, Rāchamalla that the colossal Statue of Bāhubali was set up at Śravaṇa-Belgola, by Chāmuṇḍa, the author of *Chāvuṇḍarāya-Purāṇa*.

(ix) Taila II, a Western Chālukya prince was one of Kṛishṇa III's officers ruling in a portion of the Bijapur District. During the weak rule of Kakkala, younger brother of Kṛishṇa III, Taila declared independence and occupied the Rāshtrakūṭa kingdom destroying at one stroke Kakkala, Paramāra, Muṇja, Ganga Pañchāla and others. The Paramāras under Siyaka Harsha had invaded and occupied Mānyakhēṭa during the reign of Kottiga, predecessor of Kakkala, and wrested Lāṭa-maṇḍala which was finally lost to the Rāshtrakūṭas. Thus, after a glorious career of over 220 years, the Rāshtrakūṭas disappeared from the arena of political life of the Dekkan and Karnatak.

By the close of the 10th century A. D. the old powers disappeared from the scene and a period of renaissance dawned in the political institutions and the religious and economical life of Karnatak. The system of retaining the hereditary chiefs in their conquered province was as far as possible discontinued and the territorial divisions were reshuffled to suit the needs of the administration. Governors or administrators were appointed under the authority of the king, who were liable to transfer from one division to the other. The queens and princes, and the nearest relations of the king were, after an all-round practical training in political sciences, placed in charge of an administrative unit, to ensure security of peace and order in the country.

The greatest adversaries of the Chālukyas of Kalyani were the Cholas of Tanjore who had succeeded to the Toṇḍaimaṇḍalam or the Chōlika-Vishaya of the Pallavas in the last quarter of the 9th century A. D. The Chālukyas and the Chōlas were constantly at war and invaded each others' territories. To maintain an unchallenged peace in the newly acquired kingdom, Taila II had to put down the turbulent forces of Karahāṭa, Koṅkaṇa, Mālava etc., and his son Iṛivabeḍanga Satyāśraya defeated Aparāditya of Koṅkaṇa. Iṛivabeḍanga Satyāśraya's reign is marked with a series of fights with the Chōla king Rājārāja the great who according to the Hoṭṭūr inscription had advanced as far as Dōṇūr in the Bijapur District with an army of 900,000 troops. Satyāśraya appears to have commanded the resources of the Eastern Chalukya king of Vengi and repulsed the intruder from the Chālukya boundary. The feuds between the Chālukyas and Chōlas continued during the whole career of the Chālukyas of Kalyani, the latter always taking an aggressive and attempting to create a division in the family of their adversaries. Vikramāditya V, Jayasimha II and Sōmēśvara I had to stem the rising tide of the Chōlas and the Chōla king Rājādhirāja was killed in the famous battle of Koppam which is identified with Khidhrapūr near Kolhapur, on the banks of the Kṛishṇā or Koppal on the M. & S. M. Railway line between Gadag and Guntakal. Sōmēśvara I's successor was Bhuvanaikamalla Sōmēśvara II who bore an ill-

will against his brother Vikramāditya, had soon to accept defeat at the hands of his brother and divide the sovereignty between himself and Vikramāditya. The most powerful king of the family who extended the Chalukya dominions as far as the Guntur District in the East and Nagpur in C. P. in the north and actively associated himself in the politics of the Chōla-Chālukyas of the east coast, was Tribhuvanamalla Vikramāditya VI, the founder of the Chālukya Vikrama era in supersession of the Śaka era. This era was adopted for over one hundred years not only in Karnatak but in the territories where his influence had reached during his life time. The long reign of Vikramāditya VI was occupied with constant wars with the Chōlas, the Chālukyas of Veṅgi, Mālava etc. It was during his time that the feudatory chiefs the Kalachuryas, the Hoysaḷas, the Yādavas and the Kākatiyas came to the fore by taking active part in the wars with the neighbouring kings, who ultimately found an opportunity to establish an independent kingdom during the declining days of the authority at the centre.

(x) The Chālukya power was subverted by the Kalachurya Bijjala in about A. D. 1163 whose family usurped the throne for about 20 years after which the Chālukya sovereignty was revived by Vira Sōmēśvara IV, for a short while, only to be finally divided by the other rising chiefs, the Hoysaḷa, Yādava and the Kākatiya. Thus, the last quarter of the 12th century A. D., saw the rise of the new powers in the Dekkan and Karnatak who were constantly at war for the expansion of their respective territory.

The age of the Chālukyas of Kalyāṇi was one of renaissance and reform. They were the supporters of the *Vaidika* and *pauranic* religion as against their predecessors the Rāshtrakūṭas and the Gaṅgas who were Jains, and accordingly they patronised art and architecture to promote the revival of the Pauranic school of worship. They were prolific builders of temples for Viṣṇu and Śiva, in superb architectural style which has earned a distinct name as the 'Chālukyan style' in the Indian styles of building. The temples of Trikūṭēśvara at Gadag, Kāśivīvēśvara at Lakkundi, Mallikārjuna at Kuravatti, and clusters of temples at Kukkanur, Haraḷahalli, Chaudadanpur, etc., are the fine productions of this period.

The Chālukyas were great patrons of literature and sheltered poets and philosophers with bounteous gifts. If Pampa and Ponna were the proteges of the Chalukya Arikēsari II and the Rāshtrakūṭa Kṛishṇa III respectively, Ranna was the court poet of Taila II, and Nāgavarma, Durgasimha and Chandrarāja etc. flourished in the reign of Jayasimha II. Vikramāditya VI patronised Bilhaṇa and Vijñānēśvara the famous poet and law-interpreter respectively. His successor Sōmēśvara III was himself a renowned author and composed an encyclopaedic work *Abhilashitārtha-chintāmaṇi*. The Kalachuryas were the stalwart supporters of the Vīraśaiva renaissance under Basavēśvara which ushered in a new era in the religious and philosophic Literature of Karnatak. The new *Vachana* style of composition, the throwing open of the portals of the hidden treasures of the Vedas to the masses irrespective of caste and creed and the introduction of the Śiva Bhakti element in Kannada literary works were some of the important contributions of the renaissance to the religious and social life of Karnatak.

The Yādavas of Devagiri who first appeared as powerful feudatory chiefs under Chālukya Sōmēśvara I and Vikramāditya VI, became independent rulers, under Bhillama (1187-91 A. D.), of the Chalukyan territory north of the Kṛishṇā. The Hoysaḷas occupied the portion to the South of the Tungabhadra and the doab between the Kṛishṇā and the Tungabhadra remained a covetable land for which constant wars were fought between the two families. In one of such expeditions Billama was routed and put to flight by the Hoysaḷa Vira-Battala II at the famous battle of Sortur. Siṁhaṇa was the most powerful king of the family who carried his conquests far into the interior of the Shimoga district of the Hoysala kingdom in the South, subdued the Kāyastha and Chōla chiefs of the East coast, invaded Gujarat whose king Lāvanya-prāsāda made a treaty with him in A. D. 1231. The family maintained its glory during the next two reigns of Kṛishṇa and Mahādēva.

(xi) It was during the reign of Mahādēva, that Śrī Madhvāchārya preached his dualistic philosophy of *Vishṇubhakti* which infused a new blood into the decaying veins of the people and spiritualised their out-look on life. The materialistic tendencies were however getting stronger and the rule of Rāmachandra saw the disruption of the kingdom under the invincible attacks of the Mohammadan invader Allaudin Khilji through his general Malik Kafur. The Hoysaḷa and Kākatīya were also shattered by the foreign invasion as a result of which the whole of South India and Dekkan were rolled in chaos and disorder.

The Hoysaḷa dynasty is famous not only for the various exploits of the kings like Vishṇuvardhana, Vira Ballāla II and Ballāla III but for the patronage they gave to the rise of the Vaishṇava philosopher Rāmānuja who propagated the religion of Vishṇu-bhakti throughout the length and breadth of the Karnatak and Tamil land. The magnificent temples of Belur and Halebidu which are built in the fully evolved Chālukyan style called "The Hoysaḷa style" are the finest productions of the Hoysala period. Besides other writers, the Vaishṇava poet Rudrabhatta the author of the Jagannatha *Vijaya* was the protege of Vira Ballāla II.

As stated above, the Yādavas came into direct conflict with the Hoysaḷas and extended their sway into the north Mysore towards Shimoga while the latter under Ballāla III had maintained their territory in the East upto the Anantapur District where his inscriptions are discovered. Similarly, the Kākatīyas of Warangal waged constant wars with the neighbouring Hoysaḷa and Yādava monarchs. This weakened the power and solidarity of the Hindu kings of the Dekkan and offered an opportunity to the Mohammadan invader to sweep off the whole expanse of South India at one expedition. The unchallenged march of the Mohammadan general Malika Kafur was stemmed for a time by the Hindu chief Kampilarāya and his son Kumāra Rāma of Kumata-durga near Hospet ; but his single-handed struggle to spare the Dekkan from the catastrophe of foreign invasion ended in his own disaster due mainly to the treacherous machinations of Malika Kafur as recorded in the *Paradāra-Sōdara-Rāmana-charite* of Nanjunḍa. The fall of Kampila's kingdom left no hope in the bosom of a Hindu chief to assert his power in these unsettled political conditions. But in the short interval, the circumstances had shaped themselves favourably for the rise of a new Hindu power due to rebellion of the Mohammadan

officers against their suzerain power at Delhi : and the two sons of Sangama namely Hakka (Harihara I) and Bukka I who had been the State officers under Kampila, proclaimed themselves as kings in the ancestral territory of Kampiladēva. Their kingdom was first comprised within the limits of the Hoysala country and in course of time included the whole strip of land between the three oceans except the small Mohammadan States of the Dekkan which had risen in the early part of the 14th century A. D. The kingdom of Vijayanagara had a lengthened career of over 300 years being subjected to the rule of three families one succeeding the other viz. (1) The Saṅgama dynasty ; Sāluva usurpation, (2) The Tuḷuva family and (3) Arāviḍu or Karnatak dynasty. The empire rose to its zenith of glory under Dēvarāya II of the first dynasty whose conquests in the Tamil and Telugu countries established and extended the influence of the family on a wider area. This continued with rising success until the invincible power of Kṛishṇadēvarāya was acknowledged as supreme in the whole of South India and Dekkan. Kṛishṇadēvarāya's expeditions in the Tamil land and Orissa have left an indubitable stamp of his power in those countries in the form of temples and munificent gifts to the gods.

The first dynasty was inclined towards Śaiva worship and many Śaiva poets and philosophers like Kriyā akti etc., rose under their patronage. The Sāluvas and Tuḷuvas were Vaishṇava in their pervasion and the Mādhva philosopher-saint Śrī Vyāsātīrtha was the royal preceptor of Vīra Narasimha, Kṛishṇadēvarāya and Achyutarāya, as can be gathered from the *Vyāsayōgicharita* of Sōmanatha Kavi and the numerous inscriptions found in Hampi-Vijayanagara. The Vaishnava teachers Vēdāntadēsika etc., were also sheltered by the royal support, during the Tuḷuva rule. The Haridāsākūṭa organisation sponsored by Śrī Naraharītīrtha a direct pupil of Śrī Madhvāchārya, and supported by Śrīpādarāya, Vyāsātīrtha etc., grew stronger and preached Viṣṇubhakti and spiritual love as the *summum bonum* of life. Like the *Vachanas* of the Vīra Śaiva saints on the side of Śaivism, the sonorous hymns of the Dāsas on the Vaishṇava cult ushered in an age of renaissance in literature, arts and daily routine. The temples of Vijayaviṭṭhala, Kṛishnasvāmi etc., at Hampi were the results of the new era. Like the Chālukyās of Badami and Kalyāni, the Tuḷuva kings revived the worship of Pauranic deities particularly Viṣṇu in the form of Viṭṭhala, Kṛishṇa, Ranganātha, Śēshaśayi etc., though the sculptural and architectural art had become conventionalised by the 15th—16th century A. D., the *Dāsakūṭa* of the Vaishṇava saints Purandaradāsa, Kanakadāsa etc., revived the indigenous school of Karnatak music with their original contributions which was adopted by the greatest votaries of musical art in the Tamil and Telugu countries. Tyāgarāja a well-known saint of the Āndhradēśa was a direct pupil of Purandaradāsa who is believed to be the *avatāra* of Nārada.

The height of the Hindu power under Aliya Rāmarāja was soon laid low, due to various causes, by the combined forces of the four Mohammadan principalities of the Dekkan and the power of Vijayanagara was shattered on the battle field of Rakkasa Taṅgadgi in A. D. 1565. Tirumala brother of Rāmarāja attempted to restore the family, but finding it impossible retired to Penugonda. The descendants of the main line finally took shelter from the storm of Mohammadan invasion at Chandragiri from which hill fort Śrī Raṅgarāja is stated to have

handed over to the English the site of modern Madras together with the privilege of coining money on the condition that the English would preserve on their coinage "the representation of that deity who was the favourite object of their worship".

(xii) As a saviour against the Mohammadan aggression the Marathas under Śivāji rose to power and occupied practically the major part of the North Karnatak. Their successors the Peshwas the Brahman ministers of the Marathas saved the tottering Hindu culture by their shrewd policy of empire-building with the material support of the chiefs and manpower of Karnatak. Karnatak threw in its lot with the Peshwas and with a single-minded loyalty helped to establish their authority. But the overpowering influence of the Western colonists who landed in India first as traders but subsequently participated in the politics of the country turned the tide of events and the British rule was ultimately established on the soil of Karnatak as on that of the whole of India.

(xiii) In this brief survey of the history of Karnatak, the following points deserve to be noted :— (1) Karnatak was one of the foremost powers in India from the earliest period of history and maintained its integrity till the advent of the British rule. It was conscious of its separate cultural unity till the fall of the Vijayanagara rule in 1565. But by the introduction of the Maratha sway in Karnatak the first foreign influence was thrust on the people of Karnatak, but it being a supporter of Hindu culture as a whole, its oppression was not felt though the nerve of Karnatak was not recognised at its worth; (2) The Kannada language was spoken in the extensive region from the Kaveri to the G dāvari and this vast territory was held under their sway, practically by the indigenous rulers of Karnatak i.e. the Chalukyas of Badami, the Rāshtrakūṭas of Malkhed, the later Chalukyas of Kalyani the Hoysala and Yādava rulers and lastly by the kings of the Vijayanagara dynasties, i.e. roughly during the past nine hundred years. Consequently the area presents a uniformity of culture, and the unity of thought and aspirations in the social, religious and economical life of the people. All the above-mentioned royal families have been historically proved to be the original inhabitants of Karnatak speaking Kannada in their homes. But after the fall of the Vijayanagara empire, this homogeneity of administration was shattered and the imposition of the Maratha rule on Karnatak in the 17th century A. D.—though un-antagonistic in spirit and culturally whole-some—paved the way for the disregard of the necessity of linguistic uniformity for the cultural advancement of a country. Within a few decades, the whole of Karnatak was over-run with the bias for Marathi to the detriment of the Kannada the language of the soil; (3) The influence of Karnatak in the historical period spread to the Lāṭamaṇḍala in Gujarat and the Vengi-Vishaya in Āndhra continuously for over 500 years. It may be noted that some of the Kannada families that settled in North India apparently during the political campaigns of the Rāshtrakūṭa kings Govinda III and Kṛishṇa III as well as of the Chālukya Vikramāditya VI, founded separate ruling dynasties in their new homes, to wit, the family of Nanyadeva of Nepal rulers and the Sēnas of Bengal.

Thus, it may be concluded that Karnatak was the most powerful political and cultural centre in India and maintained its international superiority until the decline of the Vijayanagara house-hold in the 16th century A. D.

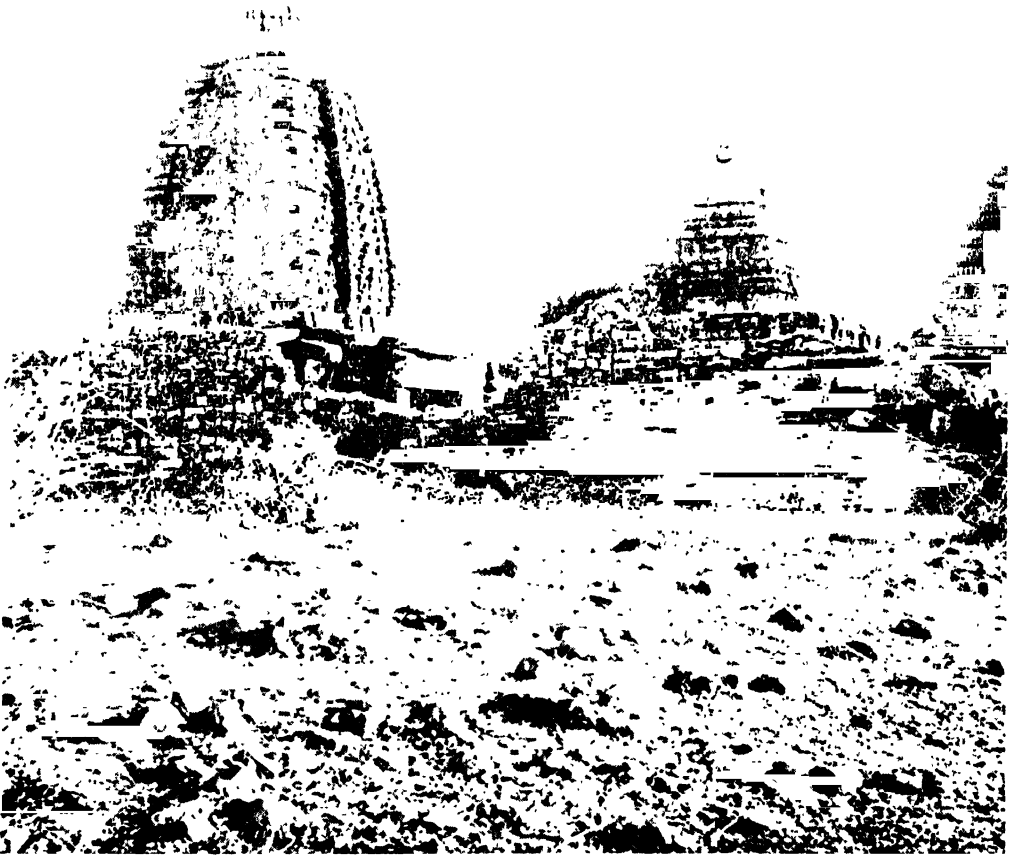




Terra cotta figures of elephant and lion (?), pots, iron slags, etc.
From Herakal [and two vases from Harri]. (Early Iron Age?)



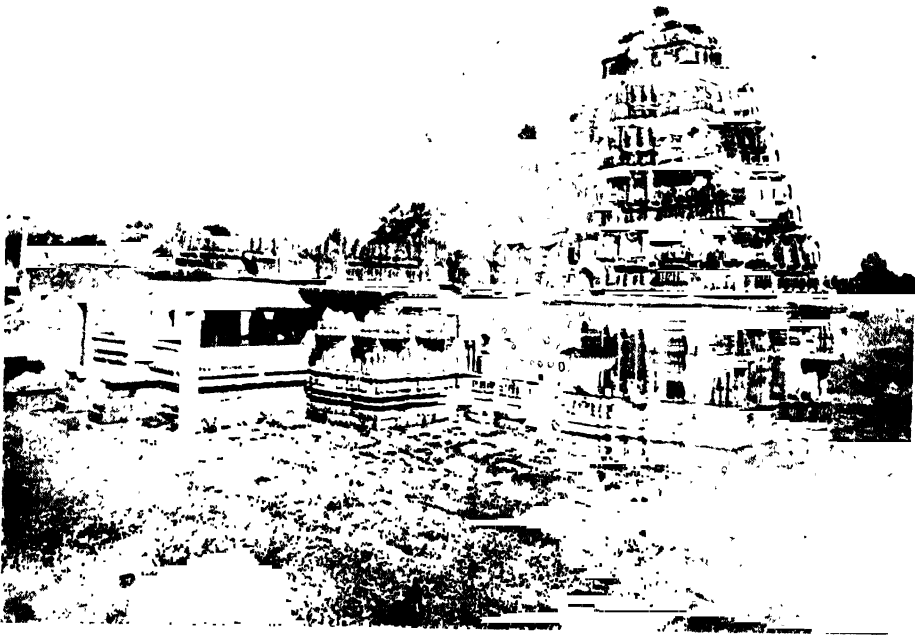
Brick and Potshards with eye-holes, finger-prints and lattice design.
From Mādhavapuri Vālgāom 2nd - st Cent B.C.



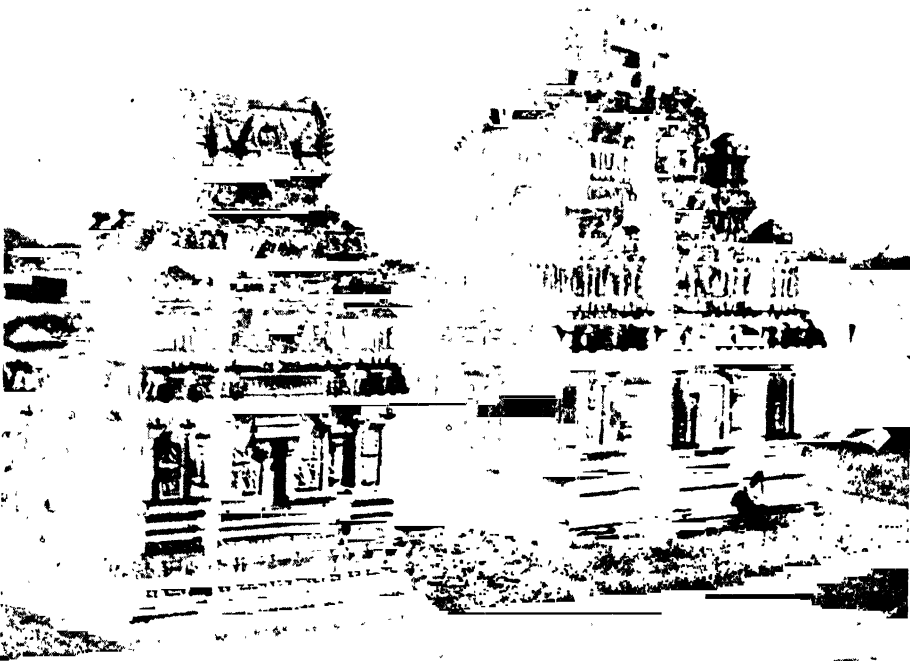
Temple of Fāpanāth, Showing Northern and Dravidian towers.
Pattadakal, Dist. Bijapur (8th Cent. A.D.)



Śiva and Pārvati from Aihole Bijapur Museum (8th Cent. A.D.)



Temple of Siddhēśvara from South—East, Haveri, District Dharwar (12th Cent. A.D.)



Hajāra Rāma temple at Hampi (16th Cent. A.D.)



Gōvardhana dhāri Krishna Bēlur, Chennakēśava temple (12th --13th Cent. A.D.)

THE KṚTA ERA'

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I

IT is well-known that the Vikrama era, now in almost universal use in Northern and Western India, is mentioned specifically for the first time in the epigraphs of the 9th century. Prior to this it was known first as the Kṛta and then as the Mālava era. The designation Kṛta is found in inscriptions from the beginning to the 5th century of the Vikrama era. Thereafter it assumes the name Mālava down to about the 9th century. That it was one and the same era that was known by these different names at different periods is a fact now well established.

However, while the Mālava and Vikrama eras derive their names from the Mālava people and their illustrious leader, the term Kṛta has remained a veritable puzzle.

II

This queer term Kṛta has exercised the minds of scholars considerably. Various explanations have been brought forward to account for its origin and its nomenclature, but none has yet met with universal acceptance.

(1) Fleet, confronted with the problem of the interpretation of the term Kṛta in the Gaṅgadhāra inscription of Kṛta year 480, reading यत्तेषु चतुर्षु कृतेषु जतेषु . . . suggested that कृतेषु meant 'made, effected, established by', and assumed the three letters preceding it as indicating the name of the founder of the era.¹

(2) Sir R. G. Bhandarkar pointed out in a discussion the inadmissibility of such an interpretation. He suggested instead that Kṛta might be taken as expressing the sense of 'four'.

(3) In the light of this criticism Fleet revised his opinion and decided to take Kṛta as meaning 'made, done, performed'. He considers यत्तेषु in the Gaṅgadhāra inscription having a practically similar sense as redundant.²

¹ Being a paper read before the Tenth Session of the Indian Historical Congress, held at Bombay in December, 1947.

² J. F. Fleet, *Inscriptions of the Early Gupta Kings, Corpus Inscriptionum Indicarum* Vol. III, 1887, pp. 73n, 75 & 77.

³ Fleet, op. cit., 73n.

(4) Dr. D. R. Bhandarkar surmised that "what is now known as the Vikrama era was invented by the people or astronomers for the purpose of reckoning years and was consequently originally known as Kṛta, which means 'made'." He is inclined to think that the Mālavas had nothing to do with the actual foundation of the era, as the phrase *माकृत्वगणाम्नात* (i.e. 'handed down traditionally' (not originated) among the Mālavas) indicates. It shows merely that the Mālavas were in possession of a traditional mode of reckoning years, known as Kṛta.¹

(5) Fleet found it necessary to revise once again his opinion. He questioned Dr. D. R. Bhandarkar's suggestion on the ground that the Vikrama era has never been an astronomical reckoning, but has always remained a great historical reckoning of Northern India. He suggested that Kṛta may be connected with Ki-li-to, the people who according to Yuan Chwang seized the sovereignty of Kashmir after the death of Kaniṣka.² Fleet's view has been rejected by Konow.³

(6) Mm. Haraprasād Shāstrī⁴ suggests that Kṛta indicates the name of the first year of a cycle of 4 years,⁵ current in the Vedic period. Upto this time only three inscriptions in Kṛta era were known : the Bijayagadh pillar inscription of the Kṛta year 428, the Mandasor inscription of Kṛta year 461, and the Gaṅgadhāra inscription of Kṛta year 480. Of these the second date leaves one as remainder after dividing it by 4, and therefore fits in with the hypothesis. In the Gaṅgadhāra inscription of 480, the phrase *यत्नेषु कृतेषु* suggested, according to Mm. Shāstrī, that 480 is the expired year, and the next year, 481, is the running one. Similarly he believes that the Bijayagadh inscription of 428 also records, very probably, the expired year.

(7) Konow disagrees with Fleet and Bhandarkar. He rejects Mm. Shāstrī's theory because every year of the era and not every fourth is designated as Kṛta. He explains that 'Kṛta is the best throw in the play of dice, when the number of points is divisible by four, and a Kṛta year is a year divided in three seasons each comprising four months.' The designation Kṛta is chosen to distinguish the era from another older one, which may be the older Śaka reckoning.⁶

(8) Dr. D. R. Bhandarkar gave up his earlier theory and postulated an altogether different hypothesis in 1932.⁷ He pointed out that the Harivaṁśa and the Vanaparvan of the Mahābhārata describe the evils of the *Kaliyuga* and prophesy that a Brahmin named Viṣṇuśaśa, will

¹ D. R. Bhandarkar, *Mandasor Inscription of Naravarman*, *Indian Antiquary*, Vol. XLII, 1913, p. 163.

² Fleet, *Journal of the Royal Asiatic Society*, London, 1913, pp. 994-998.

³ Sten Konow, *Kharoṣṭhi Inscriptions, Corpus Inscriptionum Indicarum*, Vol. II, Pt. I, 1929, p. lxxxvi.

⁴ Mm. Pandit Haraprasād Shāstrī, 'Mandasor Inscription of Naravarman: the Mālava Year 461', *Epigraphia Indica*, Vol. XII, 1913-14, pp. 319-320.

⁵ In this cycle Kṛta is the first, Tretā is the second, Dvāpara is the third, and Kali is the fourth year.

⁶ Sten Konow, *op. cit.*, p. lxxxvi.

⁷ D. R. Bhandarkar, 'The Years called Kṛta, or the Origin of the Vikrama Era', *Indian Antiquary*, Vol. LXI, 1932, pp. 101-103.

be born as Kalki in the town of Sambala in a Brahmin family, will be a supreme ruler (*cakravartin*), and a righteous conqueror (*dharmavijay*). He will exterminate the Dasyus, perform the Aśvamedha sacrifice, give back the earth to the Brāhmanas, and will usher in the Kṛta age. According to Dr. Bhandarkar this description will apply to Puṣyamitra admirably, as he was a Brahmin, a supreme ruler, a righteous conqueror, and as he celebrated the Aśvamedha sacrifice and re-established the Brahmanical religion. In the Kaliyuga, which preceded the advent of Kalki, Buddhism predominated and there was preaching by Śudras. Harivaṁśa says that this state of things was ended by Senāni Dvija, who cannot but be Puṣyamitra. As Jayaswal has shown, the Purāṇas, and particularly the Matsyapurāṇa, refer to Kalki as having actually flourished and ushered in the Kṛta age. Dr. D. R. Bhandarkar questions Puṣyamitra's generally accepted date (180 B. C.), and is inclined to bring him down to 75 B. C. on the basis of paleographical evidence. An inscription of Dhanadeva, sixth in descent from Puṣyamitra, is paleographically akin to the records of Northern Kṣatrapas, 1st century A. D. Puṣyamitra subdued the Mlecchas and became a supreme ruler and a righteous conqueror in about 57 B. C. He, therefore, is the usherer of the *Kṛtayuga*. Thus Dr. Bhandarkar submits that "the Vikrama years were originally the years of *Kṛta yuga*, and that this epoch was ushered in most probably by Puṣyamitra, the founder of the Śuṅga dynasty."

(9) Śrī D. N. Mookerjee accepts, in main, this theory, but postulates a different initial date for the Kṛta era.¹

He points to the statement in *Kalki Purāṇa* that Kalki defeated the Buddhists, the Jainas and the Mlecchas with the help of King Viśākhayūpa and introduced the Kṛta age. Viśākhayūpa was the son of King Pālaka of Avantī (528 B. C.—504 B. C.). Viśākhayūpa's reign falls between 504 B. C. and 454 B. C. With the help of Viśākhayūpa Kalki reintroduced the Kṛta era sometime between 504 and 447 B. C. Possibly King Viśākhayūpa of Mālvā marked the introduction of the Kṛta era by granting a republican constitution to the Mālavas.

Thus, Mookerjee contends, the Kṛta era should not be identified with the present Vikrama era or the Mālava-gaṇa era, but with the earlier Śrī Harṣa era of 458 B. C. mentioned by Al Beruni. He tries to support his view with evidence from an unknown work on Hindu astronomy entitled *Graha Mañjari* and the Jaina and Buddhist traditions about Kalki.

This theory rests simply on tradition and ignores the contemporary inscriptional evidence, a circumstance, which renders Mookerjee's hypothesis untenable. Moreover, the Kṛta : Mālava era has been synchronized and proved identical with the Vikrama era by a host of eminent authorities.²

¹ Dharendra Nath Mookerjee, *The Kṛta Era*, *New Indian Antiquary*, January, 1943, pp. 229-234.

² Cf. Fleet, *CII*, III, Introduction, p. 68; A. S. Altekar, 'Vikrama Samvatsara' *Sabyadri* (Marathi) October, 1943, p. 695; D. R. Bhandarkar, 'The Vikrama Era', *Sir R. G. Bhandarkar Commemoration Volume*, 1917, pp. 193-194; etc.

(10) The latest theory of the origin of the Kṛta era and the explanation of the term is propounded by Dr. A. S. Altekar.¹

He criticises Fleet's view on the ground that it cannot explain the expressions such as श्री मालवगणमाने प्रज्ञप्ते कृतसंज्ञिने (Mandasor inscription of Naravarman) where Kṛta appears evidently to be the proper name of the era. Similarly he rejects Mm. Shāstri's theory as it cannot fit in with several Kṛta records now available, viz., the inscriptions of Kṛta years 282, 295, and 335 none of which can be reckoned as the initial years of the 4-yearly vedic cycle, even if we assume them to be expired years. Dr. D. R. Bhandarkar's first proposition that the Vikrama era was founded by the people or astronomers is also unacceptable in view of the fact that none of the famous Hindu astronomers like Āryabhaṭa, Varāhamihira or Brahmagupta is known to have ever founded an era. Dr. Altekar similarly rejects Bhandarkar's other theory that the Kṛta era, a 'Kṛta yuga' or 'a golden age' was first started by Puṣyamitra Śuṅga, on the ground that Purāṇas almost invariably refer to the *Kaliyuga* as the current age, and that Puṣyamitra's time, fixed by unanimity of opinion at 180-150 B. C., can on no account be arbitrarily brought down to 57 B. C. as suggested by Dr. Bhandarkar.

Dr. Altekar's own theory may be summarized as follows : From the inscriptions dated in Kṛta calendar it appears that the era was traditionally handed down to the Mālava tribe. It does not designate any part of the era, but the whole collection of years (cf. कृतसंज्ञिने). Dr. Altekar suggests that the era may have been known by that term, because of the name of its founder. Kṛta might have been the name of a king or a leader. Though Kṛta as a personal name is not familiar in later Indian history, instances are not wanting of its use in earlier times. Thus there is nothing inherently improbable, according to Dr. Altekar, in postulating that Vikrama era may have been originally started by a king or a leader or general named Kṛta to commemorate his signal victory over the Śakas, who had usurped Ujjayinī for a while. Kṛta might have been given the title Vikramāditya by a grateful people, who owed to him their emancipation from the Śaka tyranny. Dr. Altekar also points out that Kṛta has another meaning in the Vedic language, viz., 'booty', which is not very common. Thus Kṛta will also incidentally signify the stupendous booty secured by King Kṛta. Later on when the memory of Kṛta had faded away in Mālavā, the designation naturally changed to Mālava era.

Dr. Altekar postulates this theory as only a tentative interpretation particularly because no evidence of the existence of a king named Kṛta in ancient Indian history has yet been forthcoming. Thus, as Dr. Altekar puts it, the problem of the interpretation of the term Kṛta is still an open question.

¹ A. S. Altekar, 'Three Maukhari Inscriptions on Yūpas : Kṛta Year 295,' *Epigraphia Indica*, Vol. XXIII, 1935-1936, pp. 49-50 ; and 'Vikrama Samvatsara' *Sahyādri* (Marathi), October, 1943, pp. 698-700.

III

We shall now attempt to find a solution to this rather intriguing problem.

(1) The phraseology of inscriptions like माळवगणान्नाते प्रज्ञस्ते कृतसंज्ञिते (Mandasor inscription of Kṛta 461), and कृतेषु . . . माळवपूर्ववास (Nagari inscription of Kṛta 481), indicates that the terms Kṛta and Mālava have the same relative position and should be interpreted in a similar manner.

(2) Turning to the provenance of the Kṛta inscriptions we find that all of them come from south-eastern Rājputānā,¹ touching the northern border of Mālwa. In this region the Kṛta designation was predominantly used. According to Dr. Altekar it was also a centre of an important revival of Vedic religion during this period.

(3) (i) Now this (S. E. Rājputānā, where Kṛta designation was most popular) is the same region which is referred to by Yuan Chwang as K'i-T'a and described as follows :² "From Mālwa the pilgrim went north-west about 300 li³ (or 3 days' journey) to the K'i-T'a country. This was above 3000 and its capital above 20 li in circuit. It was a rich district subject to Mālwa to which it bore a resemblance."⁴ "From K'i-T'a 1000 li is Fo-la-pi".⁵

(ii) Beal, of course, reads K'i-T'a as Kie-ch'a. But as the renowned Cinologist Takakusu notes, in Chinese Ch'a is often misprinted for t'u.⁶ Thus as the Chinese characters ch'a and t'a are liable to be confused, and as Watters, an admittedly more accurate writer, is inclined to read the word as K'i-T'a instead of Kie-ch'a, K'i-T'a in all probability represents the proper reading.

(iii) Besides, if Kie-ch'a were accepted as the correct reading, it would definitely point to Kaccha, which will not fit into the context on account of its far greater distance and the direction in which it lay relative to Mālwa and Valabhi. From the Kṛta country the pilgrim might have mistaken the westerly or slightly south-westerly direction of Valabhi for the northern ; perhaps he first went north and got on to the high-roads connecting Binnamāla and Gujarāt, and later turned to the south. But if Kaccha is accepted as the intended meaning, then the northerly journey of 1000 li (= 200 miles) from Kaccha to Valabhi will be a gross error on the part of the great Chinese savant, which is improbable. If scholars like Julien and Beal thought that K'i-t'a indicated Kaccha, that was because they did not know of the existence of a Kṛta country (the exact term we shall give later on) north-west of Mālwa. Some of

¹ Cf. A. S. Altekar, *Epigraphia Indica*, Vol. XXIII, 1935-36, p. 51.

² Thomas Watters, *On Yuan Chwang's Travels in India*, Vol. II, 1905, p. 245.

³ = 60 miles.

⁴ Cf. S. Beal, *Buddhist records of the Western World*, Vol. I, 1906, p. 266. "This country (Kie-Ch'a) is 3000 li . . . The population is dense. The establishments wealthy. There is no king amongst them ; the country is an appanage of Mālwa, and the climate, products of the soil and manners of the people are very similar in both countries. From this going north 1000 li or so we come to Fa-la-pi (Valabhi)."

⁵ Watters, *Ibid*, 246.

Vide J. Takakusu, 'A Record of the Buddhist Religion as practised in India and the Malay Archipelago' (671-695 A. D.), by I-tsing, Tr., Oxford, 1896, p. xxxi.

them are aware of the disparity between Chwang's estimate of the distance between Mālwa and K'i-t'a and the actual distance between Mālwa and Kaccha, if the latter is construed as representing the Kṛta country.

(iv) According to Watters' scheme of transcription K'i might stand for कि or खि and t'a represents aspirated dental त approaching थ. Thus K'i-t'a might approximately represent a Prakrit word like किय (किह, किहू are also possible) or कथ.

(4) The existence of a Katha (or Kaṭha) people in the centuries preceding the Christian era is vouchsafed by the contemporary evidence of early history.

The Greek writers mention Kathaians (equated to Kaṭhas by Jayaswal) as one of the most powerful 'nations' of India. Their capital in Alexander's time was Saṅkala. They enjoyed the highest reputation for courage and skill in the art of war, and shortly before their encounter with Alexander they had defeated both Poros and the king of the Abhisāras. In their battle with Alexander they did not submit even though they were tremendously outnumbered.¹ The Kaṭhas and Madrakas, as Jayaswal points out, were also known for their learning, just as Kṣudrakas and Mālavas (the latter then living on Hydaspes, i.e. the Jhelum after its unity with the Chinab) were renowned for their bravery.² The Kaṭha recension of the Yajurveda and the Kaṭhopaniṣad owe their origin to the Kaṭhas, whose antiquity reaches back to the Vedic times.³ The Kaṭhas determined franchise by birth⁴ and elected their 'king'⁵ in contradistinction to Kṣudrakas and Mālavas who had no 'king' consul, and were, therefore, required to send 100 to 150 representatives to negotiate the treaty.⁶ The Kaṭhas were originally a tribe, for Patañjali mentions कठजातीय and कठदेशीय as meaning 'of the Kaṭha tribe' and 'men of the Kaṭha country'.⁷

(5) Kaṭha or K'i-t'a appears to be the original term current in popular speech ; Kṛta is only its Sanskrit restoration, which even in its Sanskrit garb has not been able to shake off the Prakrit Instrumental Plural termination in five copies of Kṛta inscriptions (Kṛta inscription of 284, of 295, three copies, and of 335). The plurality of the inflections in which the word Kṛta appears, points almost certainly to its Prākritic origin. Such restorations are frequently met with. It is very likely that the original Prakrit word Kata signified the Kaṭha people, the Kathaians of the Greek writers and the K'i-t'a people of Yuan Chwang. As in the early centuries of the Christian era the Prakrit word कत also represented Sk क्त (cf. द्वे चिकीकृत कता Aśokan Rock Edict II, Gīrnār), the composer of the inscriptions (dated in Kṛta era), naturally, transformed the original word Kata (ta perhaps aspirated) into the respectable-looking Sanskrit Kṛta, though the terminations still betrayed its real self.

¹ K. P. Jayaswal, *Hindu Polity* (Vols. I and II combined) 1924, Vol. I, p. 64.

² Ibid., I, 138.

³ Ibid., I, 188.

⁴ Ibid., I, 120.

⁵ Ibid., I, 82.

⁶ Ibid., I, 81.

⁷ Ibid., I, 135.

IV

We have now to correlate the terms Kṛta : Mālawa : Vikrama, which are found to have designated the Vikrama era at different consecutive periods.

As legends like मालवानां जयः, मालवगणस्य जयः appearing on Mālvā coins of the 1st century B.C. would show, a great victory seems to have been won by the Mālavas and Kṛtas (in alliance perhaps with other powers), a victory which probably emancipated them from the tyranny of a barbarous foreign power. This momentous event was naturally an occasion for the initiation of an era. It was known to outsiders as the era of Mālavagaṇa, for it was the Mālavagaṇa that led the war of independence against the Śakas, and, again, it was there that the era was generally current. The Kṛtas, too, who had joined with the Mālavas in the common battle for freedom, similarly celebrated their emancipation by counting an era from the date just as the Mālavas, their brothers in arms, had done. It was of course identical with the Mālava (=Vikrama) era. In the Kṛta country the era naturally took the name Kṛta. No incongruity between these two parallel designations Kṛta and Mālava struck the ancient people, as then Kṛtas (or Kaṭhas) were almost identical with the sister-tribe, the Mālavas. Chwang's description of the Kṛta as attached to the Mālavas and the contiguity of the Kṛta country to Mālawā confirm this opinion.¹ The amalgamation of both the people into a greater Mālvā must have commenced sometime before Chwang and ended sometime after him, with the result that subsequent documents refer exclusively to the Mālava era.

The numismatical evidence on Mālava coins (मालवगणस्य जयः, etc.) precludes the suggestion that the era was originally founded by the Kṛta, and was later on adopted by Mālavas when they expanded and absorbed the neighbouring Kṛta province.

The relation of the Mālava : Vikrama era is a different problem, which has been explained by the present writer elsewhere.²

¹ Cf. Watters II, 245 : "It was a rich district subject to Mālvā to which it bore resemblance." Also Beal II, 266 : "The country is an appanage of Mālvā and.... manners of the people are very similar in both countries."

² Vide K. B. Vyas, 'The Vikramāditya Problem : A Fresh Approach', *Annals of the Bhandarkar Oriental Research Institute*, July-October, 1946.

ECONOMIC CONSEQUENCES OF INFLATION ON AGRARIAN ECONOMY: WITH SPECIAL REFERENCE TO FINANCIAL STRUCTURE OF AGRICULTURE

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INTRODUCTION

IT is well known that in India differences of opinion existed at one time, especially in the early years of war with regard to rise in prices on the condition of rural people. Seeing that the farmers are able to obtain higher prices for their produce from land, some are led to believe that the price rise is to the general economic advantage of the peasantry. At the other end, others equally well informed, have maintained that whatever would happen in theory, in practice every rise in price level has meant more difficulty and more poverty in the rural areas. The matter is indeed of great significance, for among other things, price changes have always been deemed a powerful force in effecting changes in production and distribution of wealth among different occupations and classes in society. Nevertheless, a rise in the level of prices should not necessarily be looked at as an evil. If rise in prices is followed by a flourishing industry and a stimulated growth of all productive activities, increased production and employment, a reduction in debt position and an improvement in the standard of life of people generally, it is no doubt a thing to be wished for. In fact, there were instances, when the governments of some countries deliberately resorted to push up prices through inflation in order to ward off the disastrous effects of a severe depression. Broadly speaking, however, a sharp rise in prices must be reckoned as a curse on society as it affects different groups of persons unequally, transfers wealth from one class to another, while the excessive windfalls to individuals, business-men, traders, speculators and profiteers or black-marketeers, all proceed, in a large measure, out of a sharp rise in prices. It is deplorable that even at this stage it does not appear that the administrators or the Government have any clear conception of the causes, the magnitude and the general effects of the ruling high prices as it is evident from a suggestion recently made in the Indian Parliament (Legislative Assembly) by one of its members for setting up a commission for a thorough investigation into the inflationary price spiral in order to devise appropriate measures to bring down prices. Nonetheless, agreement among agricultural economists appears at present to be substantial regarding incidence of high prices on the agrarian economy, although so far, no systematic enquiries of a comprehensive nature were conducted in this direction.

METHOD OF ENQUIRY

There are at least two ways of approach for analysing the effects of high prices on rural prosperity. In the first place, we may analyse the various aspects of economic activity that are influenced by a rise in prices in a direct or indirect way and group them for purposes of our study into some of the following headings, viz. effects on income, on rents, wages, interest and profits, or generally on production costs, on asset-liability position (on the position of general borrowing and on mortgage debt), on standard of living, and other effects like allocation of resources and on crop structure. Or alternatively, we may prefer to study the questions at close quarters by directly basing the enquiry with reference to various classes of people, such as the big landowners (lessors or owner cultivators or partly both), the middle class ryots, the small peasants, the tenants and the mass of the rural proletariat; and also, to appraise the prosperity or the reverse of different classes of agriculturists as contrasted with others like the business and trading communities. The second line of approach sharply narrows the scope of the problem, for it implies that the questions pertaining to theoretical considerations have to be left aside, unless they directly involve matters connected with policy and programme or changes in the financial structure of agriculture. A combination of these methods, therefore, seems to have more value and an approximation of it is attempted in this paper, emphasising especially questions related to changes in the financial structure of agriculture.

EXTENT OF RISE IN PRICES AND ITS GENERAL EFFECTS

A sharp rise in prices is characteristic of the last war and its wake. According to the general index of wholesale prices of commodities published by the Economic Adviser, Government of India, there was a rise from 100.3 (base: 19th August 1939=100) in August 1939 to 241 in June 1942 and 247.1 in December 1945, while the index number in March 1947 was 292.7, thus recording a rise of about 50 points after cessation of war. It may be seen that approximately the prices of commodities have risen by $2\frac{1}{2}$ times the pre-war level by the middle of the year 1942, and remained more or less at the same level during the rest of the period of war, while they have recorded a further ascent upto 3 times within the next two years after the cessation of hostilities. It must be noted that these figures of the general indices may throw light only on the broad position, but they cannot possibly be taken as sufficiently indicative of the correct situation, because it is not the controlled prices that represent the actual conditions in the markets, but it is rather the prices of the black market which really predominate the market operations in every-day-life. Moreover, the price rise is not equal in case of all commodities. It is in this variation in its incidence, the economic consequences of inflation are reflected. The effects of inflation on society are summed up by Keynes as follows: "Inflation redistributed wealth in a manner very injurious to the investor, very beneficial to the business man, and probably, in modern industrial conditions, beneficial on the whole to the earner."¹ A detailed analysis of the various causes and the course the price inflation has taken since the outbreak of the war, however, does not fall under the purview of our study.

¹ A Tract on Monetary Reform by J. M. Keynes, Ch. 1, p. 30.

DEBT POSITION

To take in the first instance the question of indebtedness, it is presumed in many quarters that under conditions created by war, agriculturists' incomes must have considerably risen and the volume of debt has been wiped out or reduced to a large extent—an impression which perhaps gained ground from a glance at the figures relating to loans and advance payments made to cooperative banks.

Table No. 1 shows a comparative statement of number of loans, amounts disbursed, amounts collected and advance collections of the primary land mortgage banks, (119 in all), in Madras Province during 1939-40 and 1944-45.¹

TABLE NO. 1

Year	Number of loans	Amount disbursed Rs.	Amount collected (includes advance payments) Rs.	Advance collections made Rs.	Increase (plus) or decrease (-) in the loan amounts outstanding to banks Rs.
1939-40	2,788	42,81,940	13,18,970	5,28,786	29,62,970
1940-41	2,846	40,77,760	18,09,756	8,57,793	22,38,004
1941-42	2,968	40,32,100	22,97,075	12,12,429	17,35,025
1942-43	1,714	23,65,160	37,84,734	24,44,201	-14,9,574
1943-44	1,283	18,24,895	35,32,425	25,31,379	-17,07,530
1944-45	1,307	24,76,977	26,07,167	14,72,982	-1,30,190
Total ..	12,006	1,90,58,832	1,53,50,127	90,47,570	37,08,705

It may be seen that in the two years 1942-43 and 1943-44 both the number and amounts of loans disbursed recorded a sharp decline, while the amounts collected by way of advance repayment of loans have taken an upward curve and risen. But there set in a trend in the opposite direction in the next year. To quote the Administrative Report of the Madras Co-operative Central Land Mortgage Bank, this is accounted as follows: "The advance payments by borrowers in the two peak years were due to the increased value of land and produce. The cost of production in the agricultural industry had increased much more than the rise in the prices of agricultural commodities. This factor has adversely affected the profit position of agriculturists and to a great extent this was responsible for the subsequent fall in advance collections."²

Table No. 2 contains further statistics regarding number and amounts of advance collections, loans cleared, etc., with sources from which payments are made during the three years (1942 to 1945) for 54 primary land mortgage banks in the Madras Province.³

¹ Compiled from the Administrative Reports of the Madras Coop. Central Land Mortgage Bank Ltd., Madras, for the years 1942-43 to 1944-45.

² *Vide* Annual Report of the Madras Coop. Central Land Mortgage Bank Ltd. for the year 1944-45, p. 2.

³ For details of the names of the primary land mortgage banks and corresponding figures for each of these banks see Chapter IV, p. 225, st. No. 19 of my thesis on the "Land system of Madras province," 1947 (to be published).

TABLE No. 2

Year	Number of loans in which there are advance repayments	Amount of loans repaid in advance Rs.	Number of loans cleared in advance	Amount of loans paid in advance in full discharge of loans Rs.	Of the total amount of loans repaid in advance, amount of repayments made taking advantage of :		
					(a) Rise in prices of agri. products Rs.	(b) Rise in prices of agri. lands Rs.	(c) Misc. sources of income Rs.
1942-43	1,410	11,76,591	632	7,74,913	5,23,533	4,92,510	1,50,887
1943-44	1,619	12,62,255	781	8,35,069	6,92,612	4,50,637	5,31,507
1944-45	1,365	8,63,818	585	5,68,467	3,64,510	3,03,122	1,26,915
Total for the three years	4,394	33,02,664	1,998	21,78,449	15,80,685	12,46,269	8,09,309

(Source : Personal Investigation)

The contents of the above table reveal that the advance payments made by virtue of rise in prices of agricultural land (that is by sales of land) are more or less equally important as those made on account of the benefit derived from rise in prices of agricultural commodities. In other words, payment of debts wholly or partially, is made possible in a large measure by sale of assets of the farmers as contrasted with profits made from farming under the stimulating influence of the war time prices. Another interesting point is that debts liquidated from "Miscellaneous sources of income" (last sub-column 'C' of the Table), payments made from outside borrowings, remortgage, sale of jewellery or other assets, and earnings from trade or business figure prominently in the order given. In this light, the statistics shown regarding payments of debts are somewhat misleading. Further the data presented in both the tables (No. 1 and 2) are taken from the working of the Land Mortgage Banks in the province. They may be interpreted, at best, to indicate the debt position of those solvent peasants who own land. There are in fact too many insolvent landowners and landless tenants or the mass of rural labour left out, to whom the land mortgage banks are of little or no avail. A scrutiny of loans classified according to amounts during the last 15 years (1930-45) also discloses that the loans granted by the Central Mortgage Bank are beyond the reach of the small landholders (who constitute the bulk of the ryot population of the province) and the proportionate benefit derived from the Co-operative Mortgage Credit by the small and petty land owners is far less than that obtained by the big, the middle class and the upper middle class Pattadars. It may be obvious from the fact that the total number and amount of loans disbursed in the lower amounts say Rs. 1,000 and below, are much smaller than the higher percentage of sums advanced in group Rs. 5,000 and over, and between Rs. 1,000 and 3,000.

The above discussion treats the problem generally and not according to the different classes of agriculturists. Table No. 3 presents an abstract of the number of families which are free from debt, partially or fully liquidated their debts, and families which have incurred or increased their debts, general and mortgage, during the period 1939-45.

It may be seen that the class of peasantry who prospered and liquidated their debts under the influence of high prices are the big landowners and a fair number of medium landowners, while the small holders of land, the tenants and the agricultural labourers who are the real backbone of agriculture in the country are hard hit. With a few exceptions, the latter class of people are not only unable to pay their old debts but in a good number of cases either actually increased their debts or had to contract debts anew.

SMALL *versus* BIG LANDHOLDER

The question of the benefit derived by the small holder *versus* the big holder out of increase in prices has been taken for granted in the past without serious consideration. The material given below forcibly lays down the facts of the case.

The following Table indicates extent of land sold and purchased by small cultivators in the various sub-registration areas of the Cuddapah District during 1940-45.

TABLE NO. 4

Name of sub-registration dist.	Total extent of land sold by small cultivators		Total extent of land purchased by small cultivators		Excess of sales over purchases (-), or excess of purchases over sales (+)	
	Wet	Dry	Wet	Dry	Wet	Dry
	Acres	Acres	Acres	Acres	Acres	Acres
Badvel ..	30.22	52.07	0.55	2.70	-29.67	-49.37
Chitvel ..	11.64	651.57	1,060.71	1,481.22	+1,049.07	+829.65
Cuddapah ..	142.37	207.91	122.89	137.02	-19.48	-70.89
Jammalamadugu ..	12.46	103.90	2.22	59.40	-10.24	-44.50
Kamalapuram ..	288.67	1,196.89	187.06	762.55	-101.61	-434.34
Produtur ..	75.53	358.58	84.01	303.42	+8.48	-55.16
Pullampet ..	nil	8.34	5.44	26.82	+5.44	+18.48
Pulivendla ..	35.79	570.31	39.29	710.16	+3.50	+139.85
Raychoti ..	11.01	166.21	10.17	195.41	-0.84	+29.20
Siddavatam	1,751.40	2,183.35	1,779.51	2,211.52	+28.11	+28.17
Vempalli ..	27.14	27.02	23.25	84.43	-0.89	+57.41
Total ..	2,386.23	5,526.15	3,318.65	3,974.65	+932.42	-1,551.50

TABLE No. 5

Table below shows the extents of land sold and purchased by small cultivators in some typical villages in Chittor District during 1940-45.

Name of village	Total extent of land affected		Extent sold by small cultivators		Extent purchased by small cultivators		Excess of sales over purchases (-), excess of purchases over sales (+)	
	Wet (acres)	Dry (acres)	Wet (acres)	Dry (acres)	Wet (acres)	Dry (acres)	Wet (acres)	Dry (acres)
1. Aragonda (Chittoor S.R.O.)	2,425.05	2,075.96	1,306.80*	744.84*	1,118.25*	1,331.12*	-188.55	+586.28
2. Petagraharam (Pakala S.R.O.)	29.86	63.44	18.06	29.28	11.80	34.16	-6.26	+4.88
3. Totatimayypalle (Chandragiri)	7.43	13.15	4.38	6.86	3.05	6.29	-1.33	-0.57
4. Avilala	34.98	90.52	19.17	49.63	15.81	39.89	-3.36	-9.74
5. Kondamarri (Madanapalle S.R.O.)	29.16	106.78	14.13	74.74	15.03	32.04	+0.90	-42.70
Total for all Villages	2,526.48	2,349.85	1,362.54	905.35	1,163.94	1,443.50	-198.60	+538.16

* Total value of sales = Rs. 283,069 ; total value of purchases = Rs. 255,817.

It is apparent that taken as a whole, the small peasants have not gained by way of adding to their physical assets of their farm estate, since in a majority of cases it is noticed that they have parted with larger areas of land than the areas they have purchased. It may be observed that although the small ryots have disposed off their lands to liquidate debts for family maintenance or for whatever reason, the areas disposed off are retained among the small ryots themselves without losing their properties to big landholders.¹ This may contain a *prima facie* case to suppose that on the balance even though the lands have changed hands, the small peasantry have not lost, if not gained by the inflationary trend of prices. To the extent the small holders have liquidated their debts without a net loss in the ownership of their farmlands, they may be said to have benefited during war. It must be conceded that no doubt that the bulk of the sales of land during war are effected by and between the small holders. However, the cases where small holders have sold their lands to big holders is considerable.

TABLE NO. 6

Table below shows the number of cases and their value where the small holders sold to big holders and where small holders purchased more lands in the sub-registration district Palkonda (Vizagpatam Dist.) during 1940-45.

Year	Cases where small holder sold to big holder		Cases where small holder purchased more lands	
	Number of transactions	Value of transactions	Number of transactions	Value of transactions.
		Rs.		Rs.
1940 ..	12	7,350	15	5,371
1941 ..	14	7,518	10	1,875
1942 ..	13	9,559	9	2,210
1943 ..	11	10,350	13	1,025
1944 ..	10	5,222	8	3,080
1945 ..	9	39,720	12	1,650
Total ..		79,719	67	15,211

¹ cf. According to the Registrar of Tanjore Dist. about 77% of lands disposed off during war by small holders are retained by small holders but only about 23% of land effected is transferred to big landowners.

TABLE NO. 7

The following table indicates the broad trends of land sales according to economic position and residence in Pedakani village (Guntur district) during 1939-45.

Year	Area affected (acres)	Price of area involved (Rs.)	Number of transactions involved										
			According to economic groups					According to residence					
			Within same groups					Among unequals		Among residents	Among non-resident	Between residents to non-residents	Between non-residents to residents
			La-bour-ers	Small ryots	Middle class ryots or business-men	Big ryots	Big business-men	Persons of large professional incomes	From small to big					From big to small
1939	25.73	6,348	1	5	nil	2	nil	nil	10	5	9	4	4
1940	61.67½	1,781	1	18	2	5	2	"	8	12	18	14	13
1941	40.18	13,888	1	14	1	nil	nil	"	12	10	19	10	3
1942	41.85	10,154	1	17	1	2	"	1	10	4	19	10	4
1943	41.95	30,918	3	32	2	1	1	1	23	7	35	14	7
1944	16.49	9,699	nil	8	3	1	nil	nil	5	1	4	4	5
1945	21.47	13,175	"	15	nil	nil	"	"	7	3	10	8	4
Total	240.34½	85,963	7	109	9	11	3	2	75	42	114	64	40

(Source = Persona investigation)

From Tables Nos. 6 and 7, it may be noted that the bulk of the transactions have taken place among small ryots themselves. But it is strikingly significant that considerable extents of land have been transferred from the small to the big landlords or big landowning businessmen, and broadly speaking the rate at which land is changing hands from the groups of small economic status to those of higher economic position is in the aggregate almost double the rate at which land is passing off in the opposite direction, namely from big to the small.

ON STRUCTURAL CHANGES IN AGRICULTURE

The foregoing discussion throws light on the effects of wartime boom on the ownership of land, or on the trends in the changes in farm ownership and the classes that have lost lands and those that have gained or acquired newly. In spite of the much advertised Grow More Food Campaign and the incentive offered by high price levels there does not appear any marked increase in the area cultivated or a reduction in the areas lying fallow or uncultivable during the period.

TABLE NO. 8

Showing the percentage variation in the total area farmed, irrigated and lying fallow in the Madras Province during 1939-45.

Year	% of net area sown to total area	% of irrigated to total area	% of current fallow to total area	% of other uncultivated land excluding current fallow to total area	% of not available for cultivation to total area	% of forests to total area
1938-39	39.3	29.1	12.4	13.6	18.2	16.5
1939-40	39.4	29.4	12.2	13.7	18.2	16.5
1940-41	39.9	31.1	11.6	14.1	17.7	16.7
1941-42	39.5	30.2	12.1	14.1	17.5	16.8
1942-43	39.2	30.6	11.7	14.7	17.6	16.8
1943-44	39.9	31.4	11.1	14.5	17.8	16.7
1944-45	39.5	31.7	11.6	14.3	17.8	16.8

One significant noticable fact is that instead of an increase, on the contrary a decrease in the net area sown and in certain cases a reduction in the average outturn of crops per acre have been observed. The area under foodcrops and pulses has fallen, even though a contraction in the alarming expansion of the area under money crops has been registered which has led to the deterioration in the food situation in the province in no small measure.

TABLE No. 9

Showing the areas cultivated under food crops and pulses and that under special crops in 1940-41 and 1945-46 in the Madras Province.

Year	Area under foodcrops and pulses (acres)	Area under some special crops (in acres)				Total Area under special crops	Increase (+), or decrease (-)	
		Tobacco	Ground-nut	Sugar cane	Cotton		Food crops & pulses	Spl. crops
1940-41	26,170,191	319,604	3,922,497	161,716	2,412,857	6,807,674	-6%	-11%
1945-46	24,534,629	281,773	3,604,999	105,253	2,034,596	6,029,621		

With regard to effects on farmleasing, level of rents and the chief patterns of tenancy, it is well known that in a period of rising prices the tendency on the part of the ryots is to contract lands in fixed tenancy, especially on cash rents in preference to other systems; whereas in a period of declining prices, Batai or sharing system is preferred. This has largely facilitated rentiers to screw up rates of rents and it is found that owing to enormous rise in prices, even waste lands or lands fit for cattle grazing are leased out on Rs. 20 to Rs. 40 per acre in many parts. Cash rents of Rs. 150 to Rs. 350 per acre on lands cultivated with tobacco and Rs. 200 to Rs. 400 on lands raised with sugar-cane are not uncommon in many regions. Expansion of areas cultivated under cash crops has been also responsible for the rapid conversion of areas from sharing system to fixed and cash tenancy systems. Owing to extension of rationing to rural parts, the rumours about the abolition of proprietary estates and the proposed tenancy legislation giving fixity of tenure to tenants and fixation of rents at an unattractive level and the agitation of the extremists in favour of "land to the tillers of the soil" are to a certain extent answerable for the visible signs on the part of some rentiers to cultivate a part, if not the entire portion of their lands. However, there is no sufficient proof to conclude that tenancy has decreased or its growth has been retarded.

COSTS OF PRODUCTION AND COSTS OF LIVING

Owing to periodical settlements and recent legislation in the province fixing maximum rates of interest, there is no rise in the assessment of land revenue* and interest on capital invested in agriculture. But on the other hand, wages of labour, rents, prices of farm lands, operating equipment and other agricultural requisites have risen. There is no marked change in the rates of wages of those who are paid in kind, while there has been a steady rise in cash wages. Cash wages have been increasingly coming into vogue replacing wages in kind. Since the outbreak of war, wages of labour have risen to 200, 250 and even to 300 %

* Note : It is noteworthy that the revision and resettlement operations which are due during war years in some parts are kept in abeyance under the instructions of the Board of Revenue in the Province. It may be noted that price changes means a special handicap to landholders if the revision settlements take place immediately after a period of price rise; and conversely it involves a loss of revenue to Govt. if the revision should take place immediately after a period of deflation followed soon by a period of price boom. One of the reasons for the Deccan Riots in the seventies of the last century was found to be the high enhancements of revenue demand based on cotton prices obtained during American Civil War. For adjusting the burden of land revenue assessment to changes in the prices of agricultural produce some provisions are made in the Punjab sliding scale system introduced in the districts of Montgomery and Lyallpur in 1930).

in some places and nowhere the rise is less than 100% of the pre-war rates. But it must be reckoned that the rise in the wages of agricultural labour as compared to the enormous rise in the wages of industrial and urban labour is insignificant. The increases in the cost of some of the items referred to vary from region to region, nor all farmers have similar structures of operational costs, as they are largely governed by the peculiar characteristics of farming and other local conditions.

TABLE NO. 10

Showing cost of production of paddy per acre on irrigated and unirrigated lands in five districts of Madras Province.¹

Districts	1939-40		1944-45		1945-46	
	Irrigat- ed Rs.	Unirri- gated Rs.	Irrigat- ed Rs.	Unirri- gated Rs.	Irrigat- ed Rs.	Unirri- gated Rs.
East Godavari ..	46-6-5	26-6-5	87-6-5	48-6-5	*126-0-0	*62-12-0
West Godavari ..	41-6-5	30-6-5	97-6-5	76-6-5	108-0-0	84-0-0
Krishna ..	38-15-5	27-13-5	76-0-5	56-4-5	76-10-0	56-14-0
Guntur ..	47-14-5	20-6-5	90-14-5	39-6-5	104-0-0*	53-12-0*
Nellore ..	46-5-11	27-5-11	82-4-5	47-7-1	49-4-0*	23-8-0

*Not accepted.

It is evident that the increase in the costs of cultivation on irrigated lands is higher than the corresponding increase on the unirrigated or dry lands, the percentage increase on these two, taken together, varying between 175 and 250%.

There can be no question about the influence of a sharp rise in prices on the cost of living of the people and in fact in all considerations of the standard of living this inter-relation of income and prices is of key importance. The average prices of foodstuffs and other articles of consumption have registered an increase of 217% to 344% in the province per maund. The variations in the prices of these articles are different in different regions, while the black market is widely prevalent in respect of these and some other articles are scarcely procurable in the countryside. Therefore, the percentage increase in the cost of living shall be more than the percentage increase in articles of consumption as noted above. The bulk of the rural people has not secured a rise in income as large as the rise in the cost of living with the result many have either to consume their assets, resort to borrowing, curtail their standard of living or effect some combination of all these.³ The consequent average deterioration of diet may be roughly estimated as 30% to 40%. For describing and measuring the standard of living, family income and expenditure rather than the per capita income and expenditure may be taken as the basis.

¹ Note : The rise in the cost of some of the operating equipment like ploughs, yokes, carts, working animals apart from implements made of iron has been found approximately 200 to 300% of the pre-war prices, cf. Also, Price control in India by Prof. J. J. Anjaria and others Bombay, 1946, ch. V.

² Compiled on the basis of data furnished by the Collectors *vide*—consolidated note of the Board of Revenue, Madras (S 5062/45-47 dated 24-1-46) submitted to the Govt. of Madras.

³ Cf. Publication No. 82 of the Board of Economic Enquiry, Punjab by Paul Green, Lahore, 1944.

TABLE No. 11

Showing average figures of income and expenditure in 1939 and 1945¹ (in rupees).

Classes	(1) Costs of cultivation		(2) Food		(3) Clothing		(4) Other necessities		(5) Ceremonies	
	A	B	A	B	A	B	A	B	A	B
1. Big landholders	506.3	1,236.1	424.6	846.4	139.6	281.4	97.3	201.3	50.3	228.6
2. Medium landholders	166.1	381.8	233.3	456.5	57.5	118.6	39.2	81.4	7.9	42.2
3. Small landholders	84.8	175.6	196.4	361.0	46.7	86.8	34.1	63.9	14.6	49.7
4. Tenants (landless)	91.2	183.9	176.9	382.3	37.9	71.9	27.7	53.9	4.0	21.4
5. Labourers (landless)	....	....	134.5	261.8	20.3	43.9	12.6	28.8	4.8	28.9

Classes	(6) Repairs		(7) Education		(8) Total expenditure		(9) Total income		(10) Surplus or deficit	
	A	B	A	B	A	B	A	B	A	B
1. Big landholders	20.6	78.7	33.7	75.4	1,272.4	2,947.9	1,925.1	4,066.0	+652.7	+118.1
2. Medium landholders	7.3	45.6	2.9	7.6	514.2	1,133.7	335.6	1,250.9	+121.4	+117.2
3. Small landholders	13.9	6.3	0.1	7.9	390.6	751.2	398.5	750.3	+7.9	-0.9
4. Tenants (landless)	7.4	6.5	0.1	....	345.2	719.9	343.3	675.8	-1.9	-44.1
5. Labourers (landless)	1.3	6.4	....	....	173.5	369.8	182.4	359.2	+8.9	-10.6

A = 1939; B = 1945.

¹ Data incorporated in the table represent the results of an enquiry into 160 family budgets in each of the five classes of agrarian strata, selected from all regions of Madras Province : *vide* statement No. XXXIV, P. 109 of the Report of the Economist for enquiry into Rural Indebtedness, Madras, 1946.

Note : The data given may be taken only as an approximate evidence, because the accuracy of any attempt at measurement of cost of living of the peasantry is depreciated owing to prevalence of the system of barter and the considerable degree of their self-sufficiency in their requirements of living.

It may be seen that the higher economic classes have experienced the higher percentage increases in income. Answers to the question what class of the rural strata has experienced the greatest rise in income and expenditure may be easily found from a scrutiny of the figures in columns (8), (9) and (10). Viewed as a whole, barring the first two classes of big landholders and medium landholders, the mass of the agrarian classes are on a deficit economy. In spite of the rise in wages of labour, their earnings lag behind their cost of living, while the class of landless tenants are the worst sufferers.

ON THE PROSPERITY OF THE AGRARIAN CLASSES

The preceding discussion throws light on the incidence of high prices on the prosperity or otherwise of the rural classes. The chief conclusions, however, may be briefly stated as follows. The general effect of the rise of prices on the rural prosperity as a whole is disastrous except that it has benefited the families belonging to the class of big landowners (lessors or owners cultivators) and a few middle class families. The chasm between the solvent and the insolvent is widened. A good number of well to do or solvent ryots have become more solvent, while the insolvents have become in most cases more insolvent.¹ The persons who are most benefited are the lessor classes, since they could enhance rents without being affected by the rise in costs of cultivation. Next, stand the class of bigowner cultivators, particularly those who have devoted larger proportion of their lands to cultivation of money crops as compared to foodcrops and cereals, if it is assumed that there are no crop failures. It may be incidentally pointed out that even the big landowners in ceded districts could not reap huge benefits on account of high prices consequent of bad harvests due to lack of rains. In this respect the great cyclone in Andhra in 1945 and the recent failure of monsoon in the districts of South Madras have proved to be special handicaps which have deprived the big owner cultivators from reaping huge profits. They have added to their physical assets by purchases of land, investment in house sites etc. The middle class ryots at any rate have not suffered, even though they are to restrict the use or consumption of certain articles to which they were previously accustomed, not so much due to inability to pay but rather due to difficulty of procuring them, as for instance kerosene, cloth and other luxury goods in rural parts. These two groups have almost liquidated their debts or reduced it to a minimum. There are signs that there is a slight tendency on the part of some to contract mortgage debts either for purchases of land or for taking takkavi loans or taking advantage of benefits extended by Government in connection with the "Grow More Food Campaign" like digging or repairs to wells etc. whereas the small landholders may be described that at their best they could keep their heads above water. Fourthly, the tenant class who represent the class of both exploiters and the exploited in the sense that they try to exploit labour they hire and in their turn get exploited by way of high rents charged by the lessors, are hard hit. Enhancement of rent is made possible due to wide prevalence of short term leases largely lasting for one year. In certain instances under share tenancy, where the costs of production have to be borne entirely or partly by the sharecropper except payment of land revenue, owing to increase in production costs without a corresponding increase in his share of the

¹ cf. *Land and Labour in a Deccan Village*, Study No. 2 by H. H. Mann and N. V. Kanitkar, 1921—Ch. VIII, pp. 149-156.

produce, the situation has turned more to his disadvantage. It may be admitted, however, that those small-holders and tenants who employ proportionately less hired labour as compared to home labour for farming operations, are relatively better off than their brethren under similar circumstances carrying on cultivation wholly or largely by hired labour. The latter class of tenants are hit on both sides due to enhancement of rents on the one hand and due to rise in wages and costs of production on the other. It is true that there has been loud talk and complaining about the rapid rise in wages of rural labour as it has inflicted great hardship to the lower fixed income groups like teachers or clerks and generally to the lower rural strata who have not secured an increase in their incomes proportionate to the rise in prices or their cost of living. Nevertheless, the rural labourer has not gained much, but on the contrary, he finds himself in a deteriorated condition on account of large increase in the prices of food-stuffs.

Now we may proceed to pass in review how the agriculturist has fared as compared with the industrialist or trader. From the tables* below, it may be noticed conclusively that the manufacturers have benefited far more than the agriculturists from the war time rise in prices. Secondly, the prices of manufactured articles have risen higher than those of any other group of commodities till 1942-43. Lastly, the traders

1 *Table showing indices of prices of Agricultural commodities for jute and cotton and for those goods manufactured from the same raw materials—(vide Office of the Economic Adviser, Government of India—week ended 19th Aug. 1939=100)

	1940-41	1941-42	1942-43	1943-44	1944-45	1945-46
Jute, raw	113	137	153	209	207	198
Jute, manufactured	132	182	187	249	252	253
Cotton, raw	125	144	161	228	188	182
Cotton, manufactured	118	178	310	424	293	271

2 *Table showing relative figures of price indices of agricultural commodities, raw materials, all primary commodities and manufactured goods—(week ended 19th Aug. 1939=100)

	Agricultural commodities		Raw materials	All primary commodities	Manufactured articles
	Food & tobacco	Other Agri. commod.			
1940-41	108	113	121	113	120
1941-42	122	130	146	132	154
1942-43	173	159	166	165	189
1943-44	295	216	166		
1944-45	265·4		206	241	258
1945-46	272·6		210	246	240

3 *Table showing the prices of other Agri. commodities with those of chief articles of export—(vide Economic Adviser to the Govt. of India—week ended 19th Aug. 1939=100)

	1940-41	1941-42	1942-43	1943-44
Other Agricultural commodities ..	113	130	159	216
Chief Articles of Export	114	137	161	237

* *Vide*, The myth of Agricultural prosperity by B. S. Navimkurve, Bombay, 1948.

also have gained to a greater degree than the peasantry largely at the expense of the ignorant ryots.

OUTLOOK FOR PROPER PRICE POLICY

It is very clear that inflation as reflected in violent price changes has been found injurious to the wealth and well-being of the bulk of the peasantry, although it might have enriched the business and the trading communities thus intensifying the evils of social disequilibrium. Therefore, the question of devising a proper price policy as distinct from monetary fiscal policy by any means is a matter of more serious concern than had hitherto been realised. Under peculiar conditions of Indian agriculture, the price mechanism, when left to itself to operate freely, is not effective enough to tend to achieve a desired allocation of agricultural resources among individual farm products or to correct certain trends in-herent in agriculture which may need correction. Apart from monetary and fiscal causes, one powerful factor for wide fluctuation in prices is uncertainty or fluctuation in agricultural production. For achieving the goals of a proper price policy, yielding results desirable from both the view points of production and distribution, many economists¹ seem to recommend the maintenance of a system of 'necessary prices' or 'equilibrium prices' such as to effect production of agricultural produce exactly in those quantities for which there is an effective demand at full employment. This may be realised by means of a storage policy combined with a planned production, area allotments and marketing quotas. The method of maintaining parity price relationships by means of a Parity Price Board is not unreservedly commendable. For, parity prices import rigidities in price and income levels and by so doing discourage needed adjustments in agriculture consequent of variations in agricultural production from year to year, besides violent changes brought about by famine, war or floods etc. cannot be adequately provided for. Moreover, parity is also found as an unreliable guide for a correct estimate of economic status of agriculture. It may be pointed out that although maintenance of 'necessary prices' is to be aimed at, any attempt to make prices completely inelastic has to be avoided. In fact, prices should be employed to serve as economic directives and not as goals. A certain degree of flexibility of prices is needed for adjustability of conditions in agriculture to the set up of general economy of the country as a whole and also to make prices to respond to changes in costs of production as well as to technological progress. But in the final analysis, that which is important and vital is not so much of stabilisation of prices of agricultural commodities rather than a policy of stabilisation of incomes of farmer's families at a reasonable level which implies in the main questions relating to yields, costs of production and generally all those factors influencing prices. As one essential part of an agricultural price policy and a policy of minimum income guarantees, a programme of stable monetary and fiscal policies, a broad nutrition programme, general provision for education at all levels and a controlled mobility of resources within agriculture and between agriculture and the rest of the economy are to be thought of as complementary measures of a non-price character in order to ensure realisation of expected results.

¹ See, The Farm Price Policy Awards, 1945: A tropical digest of the Price winning essays by W. H. Nichollas and D. G. Johnson *vide* Journal of Farm Economics, Vol. XXVIII, No. 1, February 1946.

LESSONS OF WAR FINANCE FOR PEACE FINANCE

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IT might appear strange that anyone should now turn his attention to the lessons to be learnt from war finance with a view to their application in peace-time. We are today confronted with acute inflationary conditions in almost all the economies of the world in the aftermath of World War II. Perhaps, being the last stage of the inflationary phase, we find a world-wide shortage of capital goods, transport bottlenecks and industrial unrest, all of which are causing a decline in the production of wealth. These are all the symptoms of the last phase of the boom which are meant to warn us that the 'crisis'—in the strict economic sense of the term—is at hand and that soon the economy will be thrown into the vortex of the depression. At this time, it should be the function of economists to devise ways and means to combat the inflationary forces and avoid the great impending depression by all possible means. To a cool theoretician, however, it appears that the national economies, having departed from the position of equilibrium so much as to have reached the fag-end of the boom, their sliding away into the depression is inevitable, unless of course, we are prepared to organise them on a socialistic basis. In recent decades, the trade cycle has become an international phenomenon ; and international measures are necessary to control it. No efforts in that direction are being made ; and each country is making frantic efforts to reorganise its own economy. Such single-handed measures will lead us nowhere and within the next few years, *other things remaining equal*, all the capitalistic countries of the world will find themselves in the vortex of an unprecedented depression. It is then that attempts will be started to achieve full employment in the national economies. We are then likely to recall how the problem of unemployment was solved during war-time and whether any lessons can be drawn from our war-experience to solve the problem in peace-time. We might, therefore, be permitted the liberty to think ahead a little in this essay.

A few assumptions underlying the present essay must be made clear at the very outset to prevent misunderstanding. In the first place, we are assuming an economy which is not subject to disturbances from international forces, that is to say, we are considering a closed economy. Secondly, our analysis applies only to an advanced economy like that of the U. K. or the U. S. A. and not to backward economies like those of India and China. With these two assumptions in mind, we can proceed to make a study of the lessons of war finance for peace finance.

The truth of the cardinal principle of the post-Keynesian theory of public finance that the role of public finance is to be the servant and not the master of the national economy is best demonstrated in times of war. The real problem of war finance is to mobilise and divert the maximum possible human and material resources for the purposes of war. The needs of war are insatiable and the greater the resources that the community can set free for war purposes the better. There are four ways of maximising the supplies for war. Firstly, national income can be increased by 'taking up the slack' and working the factors of production with greater intensity. Secondly, the consumption of the community can be cut down to the irreducible minimum, compatible with efficiency, so as to increase the margin between output and consumption. Thirdly, capital may be consumed, that is to say, resources can be set free by not maintaining the capital equipment of the community intact. Finally, the community can draw upon its investments abroad and/or borrow from abroad. The goods and services from all these four sources must be diverted to the prosecution of war. Money is the instrument through which the diversion is effected by the government. In order to get command over the goods and services, the government compels the citizens to forgo consumption by diverting their income to itself through heavy taxation. Countries like the United Kingdom and the United States have raised nearly 33% and 45% respectively of their national income by way of taxation during the war. Either new taxes like the excess profits tax are levied, or the rates of the existing taxes are increased. Reliance is mainly placed upon high rates of excess profits tax and increased rates of direct taxes like the income tax and the corporation tax, which hit the higher income classes whose ability to pay is greater. Tax revenue from indirect taxation seldom plays an important part in war finance owing to the fact that it is liable to impinge upon the efficiency of the poorer sections of the community, whose standard of living is very low, but who, nevertheless, are mainly responsible for the volume of the national output. The tax system during the war, therefore, becomes more progressive. But however highly pitched the rates of direct and indirect taxation may be, taxation by itself cannot cover the financial needs of war. The Government has in addition to appeal to the patriotic spirit of its citizens and raise loans from them, either voluntary or compulsory. But invariably it is found that both taxation and loans are not sufficient to cover the needs of war finance and government finds itself compelled to adopt the inflationary method of financing. Inflation is, in effect, a very crooked method of extracting 'forced loans' from the public. The ways and means of inflation are various, but every one of them is equally indefensible from the standpoint of equity, in that every method of depreciating the value of money hits the poor much more than the rich. Nevertheless, a country at war finds itself compelled to use inflation as a method of raising finance to a greater or less degree.

All the three methods of raising finance for war together increase the total outlay of the community on goods and services above the pre-war level. Employment depends upon outlay and when total outlay increases, resources which were involuntarily unemployed get employment. Availability of idle resources, rather than finance, is the main problem in a war economy. If idle resources are available the Chancellor of the Exchequer is bound to find money for paying them from one

or more of the three sources of finance enumerated above. There cannot exist unemployment in a well planned war economy. Unemployment, which is the cause of misery and hate to numerous people in peace-time, paradoxically enough disappears when it is replaced by another kind of misery, which is incidental to an all-out war. The abolition of unemployment is the redeeming feature of a war economy worth imitation in peace-time. War finance gives us the clue that involuntary unemployment exists because of the deficiency of effective demand and that if total outlay is increased, it will cease to exist. The overriding principle of maintaining total outlay at a level high enough to maintain full employment will, as the war has shown, necessitate the treatment of finance as the servant of the national economy.

This is the principle lesson which war finance has to teach to peace finance. But there are two fundamental distinctions between a war economy and a peace economy which call for modifications of the principles and methods of war finance in their application to peace finance. In the first place, the only object of a war economy, which is pursued with a single-minded tenacity, is to maximise the resources available for war. Production will have to be increased to the highest possible level and consumption reduced to the minimum possible level. The purpose of production is not consumption but victory in war. During a war, people have to undergo the utmost privations in order to win the war. This is the reason why they bear without demur such a heavy burden, which would normally be deemed insupportable, not to speak of the additional and most regressive burden of taxation through inflation. During peacetime, however, not only will production have to be increased, but consumption also. The only purpose of production during peace is consumption. Secondly, under a war economy the maximum possible available resources are diverted from the private citizens to the Government. Consumers' goods are rationed and capital issues are restricted. The smaller the private consumption and investment outlay, the better for the war economy. But under conditions of peace, government will have to recognise the private sector of the economy. Private investment activity will play a very important part in peace time. The economic policy of the government should not, as far as possible, discourage private investment. On the contrary, it should, in co-operation with the private sector, of the economy, see to it that the total outlay of the community is maintained at a level which will secure full employment. This responsibility of the state is being increasingly recognised. It is expressly stated at the very beginning in the White Paper on Employment Policy issued by the British Ministry of Reconstruction in May 1944. The problem of peace finance is, therefore, the problem of maintaining total outlay of the community at a level necessary for full employment. The object of this essay is to examine how far the principles and methods of war finance can help us to solve this problem of peace finance.

The fact that during peace government outlay is meant to maintain total outlay in combination with private outlay reduces considerably the size of the state budget as compared to that of the war. Even so, it will be much larger than the one to which we have been hitherto accustomed in peace-time. Can the methods of war finance be of any

use to us in raising the necessary finance? Inflation, with all its adverse effects on the distribution and production of wealth, cannot be tolerated in peace. The choice between the other two methods, namely, taxation and borrowing presents a real difficulty. *Prima facie*, borrowing is the line of least resistance. Deficit budgets, which have become familiar to the public in war-time, are not so alarming to them as they were two decades ago, when the classical theory reigned supreme; and it was believed that balanced budgets possessed, as it were, a divine sanction. At present, most of the people have turned heretics and they argue that internal debts are not a real burden upon the community at all. It implies merely a transference of money from the pockets of the taxpayers to the pockets of the bondholders. Besides, it has no adverse effects upon private enterprise. What is not invested in private enterprise is lent to the government. But there is a serious social danger in this method of raising finance. It increases the class of rentiers in society, that class of social parasites which claims a part of national dividend without having contributed even an ounce of energy towards its production. This consideration should urge us to see that the size of the national debt is kept as small as possible, so that we may soon have the grim satisfaction of seeing what Keynes calls "the euthanasia of the rentier" accomplished.

The last and the remaining method is the method of taxation, which is the method of orthodox finance. If this method alone were adopted to raise the necessary finance, it would involve such increases in taxation as will be simply insupportable. If the increase in taxation were of an all-round character, i.e. increase in both direct and indirect taxation, it will have adverse effects upon the consumption of the poorer sections of the community. There arises the real danger of a fall in the average propensity to consume of the community as a whole with its attendant evil of unemployment. As a matter of fact, there is much truth in the theory that depressions in a capitalist economy are the result of a low propensity to consume. A good case can therefore be made out for redistributive taxation, that is to say, taxation which has for its purpose a redistribution of incomes in the community designed to increase the propensity to consume. This would call for a greater degree of progression in the tax system, especially in the taxation of incomes. A progressive income tax, however, has very adverse effects upon private enterprise. Not only does it decrease the supply of capital, but it also discourages risk-bearing by bringing about a decline in the marginal efficiency of capital. Attempts are being recently made to avoid the latter effects of a progressive income tax. One such notable instance is Kalecki's proposal for a 'modified income tax'. Kalecki suggests that income tax should be charged on gross income i.e. before deduction of wear and tear but after deducting from the gross income all investment on fixed capital, whether for the sake of replacement or expansion. He claims that such a tax does not affect the rate of profit expected on new investment. But as T. Balogh points out, while the modified income tax of Kalecki would undoubtedly alter the marginal incidence of income tax on capital which has already been committed by investment, it does not affect the $\frac{\text{risk}}{\text{net profit}}$ ratio for capital which is yet uncommitted, i.e., new savings 'not in the business', which it would be very important to encourage. In a progressive economy, where new ventures

are needed to maintain private investment, Kalecki's modified income tax would still deter such investment, so that the truth still remains that progressive income tax discourages risk-bearing. A government, pledged to the maintenance of total outlay and the abolition of the evil of unemployment, is faced with the difficult task of choosing between highly progressive direct taxation and borrowing. The path of wisdom lies in a judicious combination of both of them. As far as possible, it is socially desirable to keep the national debt as small as possible. But the overriding consideration of maintaining the total outlay at a level high enough to secure full employment should always be borne in mind.

Most of the Keynesians have contented themselves with advocating a policy of maintaining total outlay at the optimum level. But there arises a misgiving in our mind about the success of such a policy, if left to operate alone, unsupplemented by any other measures. For, we can only ignore at our peril the idea of the structure of production expounded so clearly by Prof. Hayck. Under any given conditions of technique, volume of capital, and tastes of the consumers there is a certain definite quantitative and qualitative relationship between the consumers' goods on the one hand and capital goods on the other; there is also such a relationship among the capital goods themselves *inter se*. It is important to realise that capital goods in the economy are essentially complementary and not competitive. Any maladjustment in the structure of production inevitably leads to cyclical fluctuations of the economy. The outlay should, therefore, be directed in such a way as not to disturb the harmony of the structure of production. This might necessitate conscious planning by the state not only to maintain the total outlay but to direct it among the various stages of production to prevent maladjustment. It is worth reflecting and examining whether the whole-hearted pursuit of such a policy by the state will not land it in socialism.

As mentioned at the outset, the foregoing analysis cannot be applied to backward economies. The economic problem in the backward countries cannot be solved by the adoption of fiscal and monetary measures. The problem is not one of providing effective demand to secure full employment. The problem is one of effective mobilization of the dormant and potential resources. There is an abundance of land and labour. But capital and entrepreneurship necessary to exploit the potential resources are not available. The increase in total outlay will not call them forth; instead, it will result in inflation. The economic problem of the backward countries must be tackled from the goods end. We have to face the real aspect, as distinguished from the monetary aspect. Since the problem is not a financial one, war finance has no lessons to teach us in this sphere, and we are, therefore, precluded from discussing that question any further in our essay.

A SOCIOLOGICAL STUDY OF THE MIANAS OF KATHIAWAD¹

By B. L. MANKAD, M.A., B.T.

THE word Miana is derived from the word 'Meh' which in Sindhi language means low caste. Thus the word Miana means belonging to a low caste. This derivation seems to be fancy of some inventive brain, whereby he has successfully tried to bring upon the whole community a sort of slur or shame. Really speaking, the word comes from Mahias, i.e. those living on the banks of river Mahi. These Mianas were originally called Mahias and they were in the times subsequently called Mianas. Some inventive brain has while writing about the Mianas has suggested that the word Mianas is a pratronymic word. It signifies that they were the decendents of some Mia or Mian.

These Rajput states, the principal of them were Kanthkot, Nagar-samoi and others, did not pay any tribute to Allaudin Khilji. Not only they did not give tribute to him but they were so confident of their strength that they insulted and turned out the officers of Allaudin who had gone to them to remind them of their duty. This made the Sultan angry and as was his custom, he ordered that these states should be invaded, humiliated and annexed. Or they should be forced to pay up the tribute in arrears and a fresh heavy tribute should they be forced to pay in future. Accordingly, the brave Afzulkhan of Gujarat fame was sent with a large army and he at once marched on Mahi Nagar and captured it in no time. The Rajputs were driven to bay. They did not know what to do. They therefore, gathered together and came to the conclusion that they should lay a siege to Mahi Nagar.

The Rajputs tried their level best to take the fort but it was no easy job for them. All their efforts were useless. On the contrary, they were beaten whenever they carried on an invasion. Now, it so happened that they were severally beaten in an open field fight outside the fort. They lost all hopes and some of them advised others to give up the useless struggle. When these Rajputs were in utter despair and downcast mood a wandering Fakir went to them. He did not go to them of his own accord but one of the advisers of the Rajput Rajahs saw something extraordinary about this Fakir as he passed by their camp and he consulted him. The Fakir was more than a match for him. He said, 'If at all you people want to consult me, I wish that I should be consulted by your leader.'

Accordingly, he was requested to accompany the councillor. He consented to accompany him. Then he was right royally welcomed, consulted by the commander in chief of the Rajput army. The Fakir

¹ I do not find sufficient words to thank my Professor Dr. Ghurye, who has initiated me to the study of castes and has been a great help to me all the while.

said: "It is impossible for you, Hindus to take the fortress because on that fort is flying the banner of Mahavali Peer. He is not only the protecting saint of the leader of the Musalman army but the saint in whom even Allauddin Khilji has a great faith and it is therefore that when the banner of the saint is hoisted on any field of battle or on any fort, victory follows the chief of the army which has hoisted the banner. You should therefore give up all hopes to retake the lost fort." But when he was requested to show some way out of the difficulty, he said, "There is one way and only one way and it is that that you should embrace Mahomedan religion. You should be converted to the Mahomedan religion, read and say the prayers to Nabi Saheb and after four days dine with me from the same dish. If you think it proper to do so you can retake the fort." The Rajput chief found himself in a dilemma. There was no go for him. He, in the hour of dire necessity and need thought and thought about the question and at last after much hesitation consented to do what the Fakir had advised him to do. There was no way out of the difficulty. He said to himself that it was no use suffering a defeat and to be tortured to servile, cruel death. He knew also the abject condition to which the enemies defeated by Allauddin were reduced. He accepted the advice of the Fakir. He offered prayers to Nabi Saheb, as the Fakir had asked him to do, he dined with the Fakir from the same dish along with his other Rajput Rajahs. He along with his followers thus accepted the Musalman religion. Then the Fakir advised him to take a chosen army and to attack the northern wall of the Fort. He said that as soon as he would lead his army the Flag's green colour would be automatically changed into white colour. This was what actually happened as the Commander-in-chief of the besieging army led his army towards the northern wall of the fort. The army attacked and the wall gave way and the army could push its way inside the fort. The army inside was defeated and put to sword.

From that day onwards these Rajputs accepted the Mahomedan religion and clung on to it for ever. This fact can be proved to some extent by the study of these people from the sociological standpoint and we have reason to believe that they are still much akin to the Rajputs in more than one way, e.g. names, surnames, dress, customs and the religious beliefs, and in their way of living life and their general outlook of life. Thus the study of the Mianas becomes a very interesting study from more than one standpoint.

These days we find, say in the last twenty years or find that the Mianas are getting more and more alike their fellow-religionists. But that does not go to stress the point that they were not converts. In short, this is the long and short of the story how the brave and chivalrous Rajputs were driven to dire necessity accepted Mahomedan religion.

After this incident they went to Cutch and settled there for a long time. The Rajput blood always made them seek something in which they could show their native strength and courage. Here they had no kingdom of their own of any importance. So they took to a life of agriculture and they got themselves related to the fighting cocks in the land of their choice. They could thus keep up the fire and keep their arms unruined. They helped sometimes to turn tables in Cutch politics by taking the side of or the other potential party.

They lived and wandered about northern and southern coast of Cutch and subsequently they came to Kathiawad. They captured some part of the country on the northern coast of Kathiawad and established there. In the meantime, they had dissentioned and this discord led them to call a Durbar of Vandhia, a petty principality in Cutch. They invited him to settle their disputes and to put an end to the struggle and the strife that destroyed their unity and strength. This Durbar of Vandhia who was too glad to interfere, readily accepted their invitation and accordingly came over to Kathiawad. But the discord was not such as it may be ended in a short time. They therefore thought, that it would be better to keep the Durbar in Malia, the centre round which they had settled. They offered him all his expenses and promised to look after his comforts and convenience. In short, he began to work as a mediator and he being a cunning or practical man saw in his interest to increase the strife instead of putting an end to them. Thus, the Durbar became virtually the chief of Malia and taking the help of the adjoining Rajput states began to curb these people and keep them in check reducing their strength and limiting their activities. As the time went on rolling, this Durbar who had by now began to call him the chief of these people and established his power and there was no other go but an open struggle between the Durbar and his successors and these Mianas. He gave them a bad name, he called them the disturbers of peace and prosperity of his state and of the adjoining states and therefore it was in the interest of all states and the Kathiawad Political Agency to suppress these people and reduce these wild men to docility.

If we refer to the records, we find that the Durbar has very actively tried to reduce these Mianas to complete submission. He called them rebels and as such he took all the possible steps against them. He maintained that Malia and the adjoining territory belonged to him and his forefathers. This is not a fact. Records tell us that five-sixth part of Malia belongs to the Mianas. Over and above that Villages like Kajar-da, Hanjiasar and Navagam and a part of a village named Chikli belong to the Mianas. They are the owners of the land and are 'Mulgirasias.' Of course, the Durbar has so informed the Kathiawad Political Agency officers that he and his successors are the real masters of Malia. And therefore the agency records testify to the Durbar's claim.

When we study the facts and figures we cannot but be of the opinion that Malia and adjoining country must be belonging to Mianas. These Mianas have not only clung round Malia but they have spread over the whole northern coast line of Kathiawad and have stretched there settlement to Dwarka and Okha. The Mianas who had settled near Malia were originally farmers but they were disturbed often and often to such an extent that they left it off in despair and took to arms for they said to themselves that too much interference in their matters would force them to resist the authority with all their power and pelf. In a very short time they proved terrible to deal with. When we think of the Mianas we cannot but think of the Sikhs of the Punjab. These people can stand a very good comparison. Both are resembling each other in many respects. The Mianas not less brave, not less courageous, not less diligent, not less intelligent, not less gifted with physical and mental powers, not less robust and fine looking and warrior-like, not less chivalrous and adventurous than the Sikhs, the Mianas were unfortunate

in one thing and that was that they had nobody like Guru Nanak or Guru Govindsingh to mould them into one complete unbreakable block by inculcating in them a sort of religious zeal and a love for the mother land. The Mianas thus being leaderless and any having no great force after them fell like so many peaks of a Mighty mountain torn by winds and rain and their continuous onslaughts and attacks. So much so that, they slowly and slowly gave way to the all surrounding mighty attacks of the big states like Jamnagar, Morvi, Dhrangadhra, Wadhwan, so many other states, aided by the British India police and the Kathiawad Political Agency police. Nobody cared to look into the case of the Mianas; all wanted peace and quiet at any cost and therefore all mad after a particular object tried and became at last successful in crushing these bold and brave people of Kathiawad who could have been a pride of Kathiawad as did the Sikhs become pride of the Punjab and consequently of the whole of India.

Names and surnames. When we hear their names we are at once reminded of Rajput names and surnames. Here are some of their names and surnames.

Their names are Dungar, Puna, Megha, Jeymal, Khimji, Viso, Bhima, Petham, Raja, Dossa, Hamir, Meraman, Kesho, Lakho, Harbhum, Vala, Raimal, Sava, Maur, Mallo, Kesar, Sangan, Jiwan, Sadu, Ranmal, Parbat, Karsan, Zino, Mulu, Jiwan, Bijal, Jangh, Bharmal, Sakhaya, Musa, Daud, Mahmud, Issa, Sumar, Jusab, Abdulla, Aiyud, Haji, Alli, Allaya.

Names of Miana women are such as Jasi, Man, Kesar, Ranbai, Manbai, Puribai, Veerbai, Ranibai, Malibai, Rahibai, Achhubai, Rahima, Halima, Karima, Khatija, Fatima, Hanifa, Juleikha, Heerbai, Jambai.

Their surnames are such as Jeda, Katiya, Bhatti, Jam, Kajadia, Notiar, Khod, Samani, Sadhwani, Ladhani, Mahar, Manek, Sanghar, Musani, Molan, Dhassa, Dhoyun, Sanghar, Manek, Karani, Malani, Samani, Samatani, Sakhaya, Bayadani, Babaria, Malek, Veera, Janghia, Khora, Paredi, Talab Buchad, Ganjia, Makwana, Sodha, Chavda, Sanna, Mauar, Namori.

From these names and surnames we can make out two things, one is that many of the names of men and women are just like those which are found in Rajputs and the second thing which attracts our attention is that most of these surnames are derived from meritorious or famous men in the family. They are having 'ani' termination which signifies that there is a Sindhi ending. They have brought these names from Sindh with a Sindhi stamp on them. This goes to show that they have lived in Sindh and have been so much Sindhi that even after they left it, they have carried with them the surnames having a decided Sindhi touch or termination. Here their names and surnames can be compared with other communities which have also come to Kathiawad from Sindh such as Luhanas, Khojas. Mianas are fond of having patronymic surnames. At present we often come across many Sindhis whose surnames are Motwani, Wadhwani, Junani and so on.

Namkaran. Mianas are not Hindus and therefore they do not believe in Astrology as such, but while giving names to their newly born children they consult the members of the family especially the sister of the father of the newly born child. Generally speaking they adopt the names of some illustrious forefather and thereby they try to perpetuate his name in the family. It is therefore, we find that the name of the grandfather is often repeated in family again and again in some cases a Miana father gives his father's name to his son. So we hear or come across names like Veeraji Jasaji Veeraji or Abdula Haji Abdula. There are certain Bhatia families in which the grand father's names is thus repeated.

Thus the name is selected and given to the newly born child. A sweet dinner is prepared in the family and the members along with the paternal aunt if she lives in the village of her brother who is invited with her children. No 'Vidhata' goes to write the letters of fate in the forehead of a Miana child. And so, no ceremony of leaving a pen and a piece of paper and such other things to be undergone. Gud or sweetmeats or dates are distributed amongst children and the poor musalmans and fakirs. Namkaran ceremony is to be performed on the sixth day of the birth of the newly born child.

When the babe is one month or in some cases a month and a quarter month old it is taken by her mother along with her other female relatives belonging to the side of her father-in-law especially her sister-in-law or mother-in-law to the Durgah of the family Peer and there it is made to pay its respects and thus acquires the blessings of the Peer. The mother of the baby takes with her some dates or molasses to be distributed to the poor and the Fakir. The little children if to be found there about they are given the dates or molasses. She offers any 'Manta' she has to fulfil if she has so decided within her mind.

The mother of the infant is after this ceremony allowed to go out to attend to her outdoor household duties. But this is not a hard and fast rule for where the family Peer is situated away from the village in which a miana family lives she stirs out of the house after a period of a fortnight or a month. For, it all depends on her physical strength. If she is not able to go about owing to severe troubles she is allowed to have a rest. Otherwise she of her own accord goes about attending her household business. Generally speaking Mianis are strong and sturdy and they do not require any doctor's help. Her health in general and her strong build of the body does not bring about serious troubles even in in her first delivery.

The father or the brother of the young mother brings some gifts for the baby such as a frock coat or a silver ornament to be worn in its neck and round its girdle. He brings some Sadi, Pettycoat and a bodice for the mother of the newly born baby and if he is financially strong he gives her some silver ornament. If the father or the brother is not well to do he brings or sends a frock coat for the baby, together with his blessings for a long life. Now due to these hard times a father or a brother who is not even able to make two ends meet blesses the infant by a letter sent with someone going to the house of the daughter.

Education. As the time passes on a miana child grows into a robust baby and consequently he begins to imitate his father and if she is a girl she begins to imitate and look like her mother or grandmother. She becomes the chief cause of joy to the family and by babbling all day round is much fondled by all the members of the family. The father or the uncle whoever he may be begins to give him home education slowly and steadily telling him various tales and actual facts relating to the life and deeds of his forefathers and great men of the community. He relates to him how they lived and died, how they braved against mighty odds in life and struggled against them single handed or helped by faithful friends and relatives. Thus the little boy's imagination is well fed and roused by the stories and the tales of the people who actually lived in his family or the community. Sometimes the exploits done by the great men in his family are so vividly narrated that the child sees the deeds done before his very eyes. He is told that these deeds were done by the great men not for anything, but for the sake of their self-respect, for the sake of the honour of their relatives and dear and near ones, to oppose the oppression to which the authority wanted to subject them. He is told that those deeds were done for the noble purpose to serve which those people were out. All these go to create a great and noble impression in the child's mind the impressions of which linger in their minds for a very very long time. They take out from him the real spirit and cherish and nourish and encourage it more than any other thing can do. The noble ideal which is placed before the child is in itself a great education which can be imparted to the child. It does not end with this but he is taught how to be helpful to any one in need and dire necessity without any consideration of caste or creed. He becomes a great help and slowly and slowly to the male members of the family especially to the father or the uncle whoever he may be. He is trained in the use of arms and this goes without saying that a military education was imparted to him. He was taught riding, he was always encouraged to walk or run great and long distances, with comparative very little fatigue with the greatest possible speed. There is still in Malia a Miana named Raisang whom the writer met and there is record made by him in which he had in his youth traversed a distance of forty-eight miles in three hours and the certificate given by the political agent of Kathiawar to that effect has been read by the writer to prove its authenticity. This is an extraordinary thing in these days as it was in those days. In fencing a sword or in throwing a lance a Miana was and is still almost unbeaten in the whole of Kathiawad. There are many others who are excellent in the use of other arms but so far as swordmanship is concerned a Miana is beyond comparison. He is made more made to take interest in farming but that interest is comparatively very shallow.

A Miana girl becomes an expert so far as household duties are considered but there is one main thing in which a Miana tops other women is that she is as bold and brave, daring and dauntless as their husbands. She reminds a Rajputani in this fact that the often a Miani has openly run down her husband publicly for a work showing want of courage or bravery which is expected in a Miana. There is an instance in which a particular Miani had gone to pay a visit to her husband in Thana jail which is considered to be one of the best Jails so far as its discipline and management precautions and watch, its high and massive

building. She addressed her husband in a very mean term told her that a lion who had killed hundreds and thousands of deer was that day being tyrannised over and kept chained by a worthless dog of a jailor? It is said that the Miana though he was very angry to hear the words remained silent but next day he made his escape good from the Jail.

Sunnat Sadi. In the case of a boy when he reaches an age of eight the Sunnat sadi ceremony is performed. In this ceremony a barber is called and a very minor operation is performed by him with the help of his razor. For this ceremony the gayanja i.e. a mahomedan barber is paid a rupee and a quarter. The operation does not take even five minutes but the incision ceremony seals the fact that the boy has been a real mahomedan. The after ceremony takes a lot of time and a lot of expense. The boy as the custom goes is made to sleep on a bedstead and made to take complete rest. He is fed whatever he desires the reason is that that brings about a quicker recovery. After the incision is gone through, the father of the boy writes letters inviting his relations and friends that the Sunnat Sadi feast is arranged on a particular day and that it will be a great favour if they go to take part in it. Accordingly he makes a great preparation for the feast and on the fixed day he finds that all the invitees have come paying respect to the letters of invitation. A grand feast is served to the invitees and the boy whose sunnat sadi is celebrated is brought dressed in the richest clothes. It is a custom that the maternal uncle of the boy brings a fine suit of clothes for the boy his mother, father and other brothers and sisters if he has. If he is rich he brings costly clothes, if he is not rich he brings ordinary ones. If the boy has no maternal uncle the clothes are purchased by the father of the boy himself. He is taken round in the village on a horse back in what is called 'Fuleka.' And the acquaintances offer him presents according to their mutual relations. The party disperses after the feast and it is a custom to give the father of the boy a sum of two rupees at least as a gift on the auspicious occasion. Thus the expense incurred by the father is to some extent met with. It is a way of indirectly helping the man who spends on such occasions.

Marriage. When the boy or a girl comes to an age i.e. marriagable age it is the duty of the father and the mother and consequently of the near relatives to be in search of a suitable match. The boy or the girl have no say in matter of the choice. They have infinite trust in what their parents do for them. Sometimes a good boy or a girl is shown by a near relative and if the father or the mother of the boy or the girl finds it a suitable one they enter into negotiations through a third party. The questions as to age, appearance, pecuniary condition of the party and the family, etc., are generally examined and then after all the matters are found to the point the parents make a formal request through a third influential party and the request is accepted or granted. The Jamat (the leading members of the caste) is invited by one of the parents and the proposal is made and accepted, is made public. Molasses or dates are distributed amongst those who have been called at the same time to the children. The 'Dech' is also made public if the parties think it proper. There are cases in which the sum is openly settled and the fact is made public for such things do not happen however it is placed as safeguard in case some untoward incident happens. In that case the 'Jamat' interferes and brings about a settlement. There are certain cases in which the

parties agree to keep it a secret and in that case the Jamat is not informed and the 'Jamat' being very practical, does not poke its nose in it. There are cases in which the sum is very nominal. For a sort of understanding is reached to by the parties according to which they agree that no heavy sum should be fixed as a 'Dech.' 'Dech' means the money which the father of the bride-groom has to pay for the bride to take her from her father in marriage for his son. This sum is paid by the father of the bride-groom in such a manner that the sum may be useful to the father of the bride when he entertains the marriage party. This speaks very highly of the relations between the gentlemen. Invitations are sent to the relatives by both the fathers i.e. the father of the bride-groom and the bride on the date of the celebration of Niccah. The date of marriage fixed by the father of the bride in consultation with the father of the bride-groom.

Generally speaking the month is selected which suits the people in every respect. These people do not offer daughters or sisters to Miana living far off from the village in which they live. For they understand that not only it is very inconvenient but it is very costly. It is very difficult to keep relations close and fresh. There is a good wisdom in this principle.

The marriage party, if the bridegroom does not live same village is to be brought to the village of the bride. In that case, it is rather an expensive business. But the fond father of the bridegroom does not mind. He carries with him as many men in the marriage party as decided beforehand by the father of the bride with the father of bride-groom. He cannot, and generally if does not wish to break the cordial relation with the father of the bride does not bring more men than the number he has promised. There are instances in which the father of the bridegroom brings a big party. In that case it is clear or it becomes clear that he wants to spoil the relations between one another. The 'Jamat' notes this and interferes in this matter and forces the fellow to send away his additional men to his village or they ask him to provide for them at his 'uttsra' at his own expense. There are occasions on which the matters become unmanageable and the father of the bride if a strong man 'refuses' to celebrate the 'Nicca' ceremony. He has a strong case in his favour and his cause is taken up by the leaders of the Community. So Jamat plays a very important part in such quarrels and takes it to be its duty to settle the quarrels. It is for that purpose that 'Jamat' if kept as a middle man in case of such untoward incidents. Such cases are now rare. But we cannot say that such things have been totally stopped.

It is the duty of the father of the bride to look after the comforts and conveniences of the marriage party. He looks after them and makes the necessary arrangements. He leaves a relative of his in charge of the guests and he has to attend upon the guests of honour. The first thing that he has to do is to receive the marriage party lead the party to the resting place specially rented or arranged for it there they are made at ease and as soon as they are at ease they are called to dinner specially prepared for the party.

Dinner. The bride-groom, his father and other men who have accompanied the marriage party are taken to the house of the father of the bride's father. A rich and sumptuous dinner is served and they

are entertained in the best manner possible. One thing is not to be lost sight of and that is that the father of the bride manages the whole thing according to his capacity. And it is considered a sign of good manners to praise the arrangements made by the father of the bride and to make the most of it. Men and women sit down together though separately so that no time may be lost unnecessarily. The sweet-meat prepared is generally sweet rice or wheat flour preparation mixed with ample ghee and sugar or molasses. Condiments are well used. Over and above this dish grams, rice and vegetables are prepared in the best manner possible.

Marriage Procession. As soon the dinner business is over the marriage party repairs to its resting place and begins to prepare for the marriage procession. The bride-groom is well dressed and if he belongs to a rich family he is decked with ornaments and flowers if available. The dress that he puts on is a surval, a country coat, and a bheth round his waist he puts on a fine turban of a Morvi type and attaches shera round his face. Shera is a number of strings either of artificial pearls or of flowers. It is a necessary thing which the bride-groom must put on or tie round his face while going to the house of the bride for the celebration of the marriage ceremony. Shera is made to order. It is made ready by the Mahomedans whose business is to supply flowers, wreaths and sheras to the customers who place orders with them. The procession starts for the house of the bride by the evening and reaches their at the appointed time. It is preceded by a drum beater, and a man with a pipe. The whole party is dressed in its best and the procession goes very slowly. Slowly it goes the better it looks. The marriage party is eagerly watched by the men of the bride's party and as soon as the information reaches that the party is approaching, the father of the bride makes all due preparations for the ceremony. The family Mulla is called before hand and he too is ready with his prayers and benedictions. Every thing is tip toe. Just amongst the expectations of all the bride groom looking as fine as any youth in the world or say more handsome than any other youth comes to the door of his father-in-law. He is received by the ladies of the house of the bride's party and taken in the house with all due ceremonies. The ceremonies are still Hindu ceremonies of showing the bride-groom plough, a spindle, and such other symbols of a married life. The bride-groom stands in all his majesty straight as any thing can be. He stands as if paying no heed to all the ceremony and some one may say that he stands and accepts all the things said or shown by signs. He is taken in and made to sit on a fine soft seat specially kept for him. The other members of the marriage party who have accompanied the bride-groom are also well received by different male members of the bride's father side. They are made comfortable and as soon as they are made comfortable they are offered Supari (Beetle nut) and dried dates. Just at this time the ladies are received by the women folk. They begin to sing songs. They are also well seated and offered dried dates. The whole party is busy talking and singing and appears in the best of its moods.

The bridegroom is called by the Mullan and made to sit on the seat which is offered to him. The ceremony now begins. The serious and grave looking Mulla sends two men inside the house the place where the women folk are sitting and singing marriage songs. One man a grown up and serious looking from the side of the bride-groom and an other from

the side of the bride. One is called a Vakil and the other is called the Sahed or a witness. The Vakil asks the bride who is sitting in the midst of women of both the sides. "Do you wish that your marriage ceremony to be celebrated with so and so the son of so and so?" She gives her assent. The witness takes note of it and both these gentlemen return in the booth where all the people are sitting and the bride-groom and the Mullan are sitting they convey the bride's assent and the whole meeting of men of both sides take note of it. Thus the marriage is settled by the assent of the bride. The bride sitting in a house sits well decked in her best dress and she puts on all the ornaments she has got from her father and the father-in-law. Generally speaking she puts on a 'Sadi' of a fine make, a petty-coat of silk and a bodice of silk too well embroidered and decked with gold and silver threads. The 'Sadi' too that she has put on is very costly and with a gold lace.

The father-in-law brings with him a full suit of clothes for her and if he is able to afford he brings and offers other suits of cloth over and above that the ornaments are a neck-lace made of gold ear-rings a ring and silver ornaments to be put on the legs. New clothes and new ornaments put on by a young bride becomes her very much and she becomes the centre of the whole circle. She looks as if she is the ornaments of the women who have assembled there. The father of the bride is sitting chatting with the guests and the Mullan on hearing the assent report from the Vakil and the Sahed puts his seal—the holy seal to the marriage contract. The father of the bride gives a full suit of clothes to the bride-groom along with a gift of a ring if he is able to afford it. The ornaments which are presented to the bride are 'Zarmar' 'Ek Danio' both of gold, Bangles and ear-rings. 'Kadlan', 'Chhada' made of silver are to be worn in legs. The total cost of these ornaments go up to two to three hundred rupees. These ornaments become the property of the bride and they remain in her keeping or custody but out of respects she lives them under the care of the mother-in-law who gives her these things when she wants to put them on. In case she becomes a widow the ornaments and the clothes remain under the custody of the bride-groom and she is not allowed to take them away to her father's house. At the same time if she chooses to remarry the ornaments and the new clothes which are used or not used are not to be taken away by her to the house of her new husband for in that case she has no right whatsoever to the belongings of her deceased husband.

As soon the Nicca or marriage ceremony is over the Mulla is paid by the father of the bride groom and the father of the bride a sum of ruppee and four annas. He is paid more than this sum but it depends on the pleasure of the father of the bride-groom and the father of the bride. He by right cannot expect more.

The marriage being over the bride-groom goes about in the marriage booth shaking hands with all the members of his family especially elderly people and by 'salaming' them they are expected to offer their good wishes to the new couple. This being done he goes inside the house where his mother-in-law and the ladies of his father-in-law's side are sitting and there he offers his sallams. They accept these and bless the new couple in return.

Night is far advanced and children of the bride groom's and bride's party are actually dozing when the party starts for the resting place accompanied by the bride. The pomp now is not so much as it was just when they were going to the house of the bride to marry her. The procession is slow but not so orderly because the ceremony for which they had gone is finished. The purpose is served they do not now expect to create any superb idea about their position etc. Again they are tired and want rest more than anything. The bride-groom with the bride goes along the street slowly and in a short time they reach the destination. The women are singing songs of joy and they look completely satisfied with the errand on which they had started.

The bride is accompanied by her younger brother or her younger sister who accompanied her to bear her a company. The other reason is that as soon as she reaches the house or the resting house or Uttara of the bride-groom she has to return to father's house and they may serve as a company. As a good men she is sent with the bride-groom as soon that is done she returns with her brother to the house of her father. The party wanting to have the well deserved rest goes to bed, to rise up early next morning for on the next day the marriage party leaves for their own village accompanied by the bride.

The next day a rich dinner is served to the bride-groom's people. A sweet rice or sweet balls or Biranj together with some salty preparation such as Ganthias—a gram preparation or hotch-potch is prepared to serve as salty preparation. The marriage party is just made to take or consume as much as possible and to be as merry as possible and the whole feast is attended by all the possible joy and merry making for that is the last feast that the marriage party is expected to have at the house of the bride. It is therefore they make as merry as possible and enjoy to their heart's content. They do full justice to the dinner and the hospitality of the father of the bride the marriage party takes leave of the host.

Just after the marriage feast is over the bride-groom and his party begin to make preparations for the departure. Accordingly the father and the mother of the bride are given to understand that the marriage party is to start at a particular time and therefore they are to make her ready with her clothes etc. In the mean time the father of the bride has kept ready all the things he wants to offer to his daughter as gifts. These include house-hold things of everyday use such as bed, a cot, a box to place clothes in, brass vessels for fetching water from the well, the brass pots used for cooking purposes and so on. The clothes he has to give and other gifts which he has given and the gifts which some of his relatives and friends are to offer are also placed there and the men and women relatives and the acquaintances of the village are informally invited to go to the house of the bride's father and have a look at the things so nicely arranged by him and his wife. There is nothing but the words of praise for the things shown. All admire the things and announce them fine and beautiful. This show is kept for a few hours and if the marriage party is to start soon the show is wound up and it is arranged and packed up to be sent with the bride.

When the marriage party starts for the house the father and mother of the bride and their other relatives go to see them off and to pay them the cost of all sundry things they might have purchased from the local

market. They also go to bid them farewell and they give a word or two of advice to the young bride, and to console her if she gets nervous. The father of the bride and the father of the bride groom pay off the 'Dads' or dues to the barber, potter, the pipe walla and others who have rendered them services during the auspicious occasion and the stay of the party in the village.

The party starts amidst the rejoicings of the bride-groom's relations and the sorrow or tears of separation of the relatives of the bride sometimes the bride herself sheds tears of the pangs of sorrow on account of the separation from her parents and the long years' connections with the house and its surroundings and the separation from her friends of childhood. However, this is a momentary sorrow which in a short time changes itself into a joy of higher type.

She is made to stay in the house of the father-in-law for a week. She gets in touch with the new surroundings and slowly and slowly gets conversant with the customs and manners of the new house where she is a complete new-comer and a stranger. She begins to study the nature of the father-in-law and mother-in-law and the brother-in-law and the sister-in-law if she has any, and other relatives of her husband. It is something like entering a new world all together.

A brother of the bride or if she has no brother her cousin goes to the house of the sister to take her back to her father's house. The reason is that a long stay in the beginning in strange atmosphere and surroundings becomes rather difficult thing for the young girl. There are cases in which the young bride has to make a long stay in the house of her husband due to certain untoward circumstances such as of having no mother or no father and no mother. In such cases too, some near relation of hers calls her to stay with him or her for a few days in order to make her not feel the absence or loss of her mother or parents. She goes to stay with her mother and father but now she cannot stay with them for a long time for she now belongs to a separate family and she has to go according to their wishes and orders. But the new experiences of the new life are of such a strange type either of pleasant kind or of an unpleasant kind that some times they are even undescrivable. In this manner she is to go to her parents and as soon as the newness of the husband's house disappears and she becomes like an inmate of the family she naturally does not like to pay any visits to her parent's house. For in the course of time that house of her parents' appears in her eyes the house of some stranger because she feels herself a member of the husband's family and she is more at home in her husband's house than in the house of her father.

In the mean time the bride being mature she undertakes all the household duties and she begins to make her mark in the family pleasing all by her work and manners.

In a short time the parents of the husband hear a happy news that the new entrant in the house has begun to carry and all expect to have a son in a short time. As said before she is called by her father to go to his house to give birth to the child. If there is no objection the request of her father is accepted. She is sent to his house when she is running

the seventh month. If there is nobody to take care of her in her father's house the father-in-law is not requested or if he is requested he refuses to send her to her father's house. In that case she gives a birth to the child in the house of her father-in-law. The good news of the birth of a child are sent to the parents of the child i.e. the news are sent to the house of the father of the child or the mother of the child who give present a very small present to the carriers of the happy news. He is offered a molasses piece to sweeten his mouth. The father of the bride has to spend about fifty rupees by the way of giving some frock coat to the baby and presenting some good clothes to the mother and her father in and her mother-in-law and he has got to send some good present by the way of a turban to the son-in-law.

After a month or a month and half she pays a visit to the house of her father, if she has given birth to the child at the house of her father-in-law. When she gets some valuable presents from her father and other relatives.

Divorce. A Miana is allowed by the religion he professes to marry more than one wives. But the economical condition prevents him from doing so. However, the religion stands by him if he chooses to marry more than one wife. This leads him to an evil, for if one does not get on well with his wife or if their natures do not agree, he reports the matter to the Jamat or if he does not report the matter to the Jamat the wife reports the matter to her parents they interfere and taking the case on hand they approach the Jamat and accordingly the Jamat holds a meeting, discusses the facts and gives the judgement and allows the husband to divorce his wife. The wife gets a divorce against the husband who fails to do his duty as a husband or treats her cruelly, beats her or does not feed her or does not earn to run on the household. In short, any kind of differences between the husband and the wife on a trivial or serious matter ends in getting a divorce. The relations are brought to an end. In this case the wife has to leave the house of her husband with nothing that belongs to her though she is given presents by him or by his relatives she has to leave them for she has not got any right to their possession. She goes to her parents house and after staying there for sometime she and her parents in some cases go in search of a new match. Generally the parents now do not interfere in this business for it is solely her business and she manages it as she chooses. The parents have got nothing to do but give their assent. She accordingly settles the matter with some Miana and settles a day when she goes from the house of her parents and begins her new married life which is practically not a married life but so called married life. The Miana to take to a new wife in the same way for the divorce case is known throughout the members of the community and that is an indirect news to others who are actually on a look out for a better or more suitable match. Naturally the news leads to many overtures from so many quarters for the freed husband or the freed or divorced wife approached by other clients. The sum and substance of the whole thing is that no party remains unengaged. There is a market for anything and everything. It is a matter of chance to get a good partner or a bad partner any how one is to be sorry for or no body is doomed for life if he happened or by chance locked up or linked up with a disagreeable party. For, divorce is a great boon to the community. One can easily correct his or her

mistake from the day he wakes up he can easily shake off the disagreeable party and go his or her own way. But there is one bad feature of this custom and it is that morality as such or ethics as such generally are absent from these people.

Women are notorious for their loose character. They take to any fellow that comes across or attracts her attention. One cannot rely on the chastity of a Miani. For she has no restriction and it is considered as her cunning or cleverness. There are instances a woman has selected seven different husbands in her life and discarded them all in their turn. In the same way we can say of a man. There are instances in which when a Miana goes out to sea he leaves his wife and when he returns he divorces the old and manages to take up a new wife. This appears very strange to those who are believing in monogamy. However it depends on the custom of a community in which one lives and dies. So this is by the way of a remark. There are many quarrels taking place every day in Miana villages wherein if one Miana has taken any liberty or cracked a joke, the party concerned directly takes a recourse to asword or a knife. The result is often disastrous for the person who has violated the rules of etiquette, his friends and the person who is actuated by anger to punish the wrong doer. It ends sometimes in bloodshed and sometimes in murder. Any how the whole thing goes to undervalue the whole community, in the eyes of all the people who live with them and those who are unfriendly with them. This gives a very nice cause to those who are out to mock at them and those who are out to establish the fact that the Mianas are wild, unruly and barbarous people and therefore they are a curse to the society in which they live. These people do not shirk at all from punishing the women as well as men in an old antiquated rude and wild way. They often cut the nose or the ears of the wrong doer. Thus, they make it impossible for them to move about in society. Internal dissensions which these incidents create are so great and so unextinguishable that they leave behind them not only ill name but life long and in some cases enmity which is hatched by people for generations. Such internal feuds have always contributed to their weakness, poverty, helplessness, and shame. If asked as to why such things are allowed to take place in their community they are either non-plused or they say that such are things for which we should be sorry for they are the things which are ordained to occur. They take no steps to end such quarrels. The reason which one can attribute is that they are illiterate and that they are living out of the way that is to say that they have not come in touch with literate people and that they are not shown how to live and how to behave with one another. They are totally in the dark as to how the world about them is living and making progress in all respects. In this case they are to be pitied than to be hated or looked down upon.

Dervatun. In connection with the customs of the Mianas it must be added that a Miani after the death of her husband has customs Dervatun no objection to accepting the younger brother of her husband as her husband. The custom is prevalent in shepherds and such other Hindu communities and the Mianas have accepted it and introduced in the community. It is believed that the custom is nothing but the customs which are accepted some times by people by living in contact with other community. This is not a custom which is very prevalent but these people

raise no objection to any Mianis accepting the younger brother of her dead husband as her new husband. The second custom which is found prevalent is that a paternal aunt will always have a preference over others in the question of asking the hand of her brother's daughter in marriage for her son. That is to say a niece will follow the paternal aunt in her family. If a paternal aunt has a son of a marriagable age and the brother has a daughter of a marriagable age she will always ask her hand in marriage for her son and the brother in ninety-nine cases out of hundred accept her request. This custom is also found prevalent even in Rajputs. It is likely that the Mainas must have kept retained this custom, the old custom which was common in Rajputs. The question as to how a particular community accepted or followed the wake of a community living in the neighbourhood of the community is worth thinking about or worth giving a special thought to. In the first place it is either a contactual or due to the daily contact with the community living in neighbourhood. The other cause why a particular community accepts or adopts a custom prevalent in other community is that that the community which is a convert community does not think it proper to give up the old remembrances of the old community or takes a special delight in keeping old connections and revering them. It is therefore that the surnames common in Brahmans are found prevalent in Boras or the surnames common in Rajputs are found common in Mianas, Kolis and so on. The third cause which can be given is that when a particular class of people have for some time dominated upon a particular community the dominated community or a class of people have tie to one sort of pressure or any other sort of pressure or due to some influence have perforce or by the force of imitation or for the same of pleasing the domination class to adopt the custom prevalent in the dominating class of people. We have thus adopted many Mahomedan and European customs and have been following them in our life. Sometimes when a class of people is out for reforms goes out to see or to observe and marks that there is a particular custom and it had contributed to their betterment the class of people accept it and begins to follow it. This and many other causes can be assigned to how a particular community follows a particular custom prevalent in other communities.

Death rites. When a particular Miana or a Miani expires, the dear and near relatives are informed to that effect. They hasten to the house of the deceased. The Mullan is also informed to the effect that a particular gentleman who was ailing for sometime has expired. He goes to the house of the man and begins to console the inmates of the family. Mullan's presence in the family is a great consolation for it is his presence that counts with these people. There are some two or three members of the family of the deceased who go out to the bazar and buy a piece of cloth thirty-two yards long to cover the dead body with. Some male member from the family goes to the Jamatkhana and orders out a bier or 'Janaja' as it is called. According to the custom prevalent in the musalmans the relatives are not allowed to shed tears or to show any external signs of grief by crying out wildly. They are to compose themselves and remember Allah and pray for the good of the person dead. In spite of this custom it is very difficult to be above feelings of joy or sorrow. One in the ordinary run in life finds it very difficult to suppress these feelings when they are put to test. Naturally therefore, the dearest and the nearest weep and express the feelings of their heart in usual ways.

It depends on the death or the nature of the death. If it is some one who is old man that is dead people take it lightly and if anyone young person has expired the people naturally feel the most and they give every sort of expression to their feeling of sorrow and grief. Any how the male members of the family mind their own business. If necessary they ask or request mildly the woman folk to check themselves. In the mean time the bier or 'Janaja' is brought from the Jamatkhana. The long piece of cloth is also brought from the market. The dear and near relatives have also come and the friends of the person dead also have come. Now the Mulla with the help of others who are standing by the person dead takes out all the clothes that he or she has put on and washes the dead body with seven water pots of cold water. Of course, if a woman has expired the business of taking out or taking off the clothes rests with the women folk. The bath with cold water gives a sort of freshness to the body and all the bad odours due to the disease vanish due to the bath. This custom is prevalent in many communities especially a woman who is not able to stand delivery pains and thus succumbs to these pains are before she is carried to the cremation ground given a good cold bath even in Brahman community. This water is brought by the members of the family from an adjoining well. The body is cleansed afterwards and after that it is taken and wound with the piece of cloth that is specially brought for the purpose. Just at this time the Mullan spreads a new piece of cloth brought by the nearest relative of the person expired specially for the Mullan to spread and say his prayers on it. This cloth is called a Mussalah. The piece of cloth or the Mussalah on which he has said his prayers for the dead person belong to him. He takes the piece of cloth. Before the dead body is wound up in the cloth the Mulla with the help of a needle and thread sews a Kaffan for the dead person. This is done very swiftly because the dead body is to be taken for its burial to the graveyard. The Kaffan being ready the person of the dead one is put in the Kaffan very reverently. There is a soft cushion in the Janaja and the body is laid upon it by the relatives very reverely. The body has this piece of cloth purchased by the inmates a son or a father or a mother or a sister or a grandfather whoever he or she may be. But there is a custom that the dead body is to have seven covers of different kinds of cloth purchased by the other relatives and when these seven covers are properly spread on the dead body the nearest relative considers it to be his duty and a privilege to respect the dead body with flowers and other scents and attars. Bottles of scents and attars are emptied by the relatives with tears in their eyes. This is done when the person dead is a young person. Scents and flowers are generally used in the case of old expired persons.

Khatmi. The clothes put on by the person dead at the time of his or her death are taken away and they are given away to the poor persons, Musalmans at least and to the fakirs. The poor and the destitute, the fakirs and children are fed with sweetmeats and given alms for the good of the person dead on the fourth day. This ceremony is known by the name of Khatmi.

In the grave yard the grave dug is from the south to the north and not east westwards. The reason is that Mecca is situated in the north of India and the Janaja is a wooden bier with a railing and a pair of poles to enable the persons to carry it on their shoulders.

The dead body is carried to the graveyard by the members of his family and the nearest relatives who consider it a piece of religious duty to carry the Janaja. There are some who are of the opinion that by carrying a dead body on the shoulders one acquires a religious merit of an extraordinary kind and the good is meted out to them by the Almighty. However, it is a religious duty which the dead person expects at the hands of the nearest relative. Uttering the name of Allah the party starts for the graveyard. One of the relatives carries the burning loban incense just in front of the dead body. This is meant to ward off evil spirits or dissatisfied spirits who are said to be hovering around the dead body and want to join him or her to their strength. The name of Almighty is said to be antiseptic. The procession is a very serious one. The Mullan is saying his prayers going along with the procession. All the mourners go after the dead body with the ordinary dress they put on in their daily life. They are not expected to have a bath as in some Hindu communities. They go with their shoes on. The people meeting the procession on the way keep standing by the way out of respect for the dead person. As soon as the party reaches the graveyard it is received by the keeper of the graveyard and the party is shown the direction in which the grave is kept ready for the dead. The Janaja is lowered down slowly and placed by the side of the grave which is dug and kept ready by grave diggers who have finished their duty and disappeared from the dismal scene. They are paid afterwards for their labours. They being expert they need no instructions as to how the grave is to be dug for it has become their business and they are expert in that kind of work. As soon as the Janaja is placed on the ground by the side of the grave the Mullan spreads again his Mussalah and begins to say prayers for the departed soul. By this time the mourners stand by the side of the Janaja. Some of the near relatives take off the flowers and wreaths of flowers which are placed on the seven coverings. They also take off the seven coverings keeping only the Kaffan with the knot on the head and the knot near the legs of the dead person for with that the dead body is to be lowered and placed in the grave. The Mulla has already said his prayers and the finishing of the prayer is a signal what the relatives are expected to take up the dead body from the Janaja and lower it in the grave with all serenity and sorrow they are capable of. With tears in their eyes the mourners, the nearest relative of the dead person lowers the dead body in the grave and places it after duly cleaning the grave that is to say after removing all the stones and pebbles, etc., that is to say the hard things which may be lying there. There are some who spread soft earth in the grave and then they cautiously place the dead body with the Kaffan on its body. Just after this the relatives and the Mullan himself throws dust on the body so as to cover it up. After the leading mourner has put a handful of dust on the body other mourners who have accompanied the beir do their part of duty by throwing handful of dust or earth which is lying by the side of the grave. In no time the grave is filled up and made a level of the common level with the surrounding ground. They then go about and take big stones and place it on the grave and then they go and find in search of thorns and thorny bushes and place them or arrange them in good manner so that no body, no animals like grave diggers can come and dig up the grave and may not take out the dead body. It so happens that grave diggers haunt the grave yard dig up the graves which are not properly guarded by such stones and thorny bushes. After doing this part of the duty the mourners go forty

paces from the grave and turning towards it they stand in a row and offer Fatia prayers so that the soul of the dead person may rest in peace. The Mulla leads the prayer and the mourners repeat it. After praying here and just at the time of burial ceremony the mourners go homeward with their sorrowful faces and slow steps knowing within themselves that they have left their relative and friend in the grave yard and they are now not going to see his or her face any more in the world. This thought prays heavily on the mourners for the time being and dipped in these sorrowful thoughts they return home that is the house of the person dead. There before they reach the house just forty steps away from his house they again arrange themselves in two rows just as they had done near the grave and forty steps homewards from the grave repeat the Fatia prayers led by the Mulla. This prayer being said they reach the home of the person dead and thence they return to their individual homes, taking leave of the head of the family in which the death has occurred.

Just at the time of dinner the relatives bring their cooked food from their house and they do not allow the family in which death has occurred to kindle fire and prepare their food. The members of the family in which death has occurred are requested and pressed upon to take their dinner with the relatives. For they are in such a bad gloom that they do not desire to take their dinner owing to extreme sorrow. The relatives all sitting together take the dinner brought from different houses. This practice is followed for about a week and all the relatives coming from other villages to express their sorrow are always made to take their dinner with the relatives of the person dead.

On the fourth day the poor and the destitute are fed and alms are given to them and to the fakirs. Khatmu is read by the Mulla and as said above the clothes the dead person has put on are given to the Mulla. Over and above these things the dear things to the dead person also given away to the Mulla. The meaning behind this is that these things reach the dead person in the other world. It is a common belief both in the Hindus and the Mahomedans that the spirit of the person must be respected and must be satisfied by supplying these needs.

Chalismu. On the fortieth day of the death of the person sweet dinner is prepared and the poor and the destitute Mahomedans and the fakirs are fed. Even the children of the family are fed. Alms are given to the poor deserving Mahomedans. The Mulla reads a prayer and it is believed that the spirit of the dead person feels better or happy in the other world. Feeding the poor and the fakirs, feeding the children and the destitute always contributes to the happiness of the spirit of the dead person. It is very similar to our Hindu belief that any good thing done in memory of the dead person always does him good in the other world. After a week masons are ordered to build a tomb on the grave. Every year on the Tabut day the relatives go out to the grave yard after the Tabuts are taken to their respective destination. They go there to respect the dead person of the family. They take with them a jug of milk and wash the tomb with it. It is believed that this soothen the spirit of the dead. A new cloth cover is spread on the tomb and the loban incense is burned before the tomb. The poor people are given alms and sweet food. This is done every year and this is just like our Shraddha ceremony wherein we remember our dead relative and offer sweet food to the poor and our Brahmans and give him Dakshina as much as we can afford.

Religious beliefs. Mianas are Sunni Musalmans and they offer Namaj prayers five times a day regularly. They observe Idd fasts and observe Ramjan fasts. They pay respects to the Peers or great saints who have shown them a special favour or obliged them or in whose good graces they believe that they are. They observe the purity as preached in their scriptures. But not being educated they cannot reap their holy books. One thing which attracts the attention who comes in their contact is that they are still side by side with the following of the musalman religious beliefs they are offering prayers to the goddesses of the Hindus. They kindle ghee lamp just at the place where they keep their water pots. They worship Ganpati whenever they begin any thing which is considered auspicious. They apply Kumkum mark on their foreheads when they celebrate marriage ceremony. The father and the mother of the bride and bride-groom and the bride and the bride-groom apply this Kumkum mark. In Navaratri holidays we find Miana girls going about the streets singing garba songs with Garbas on their heads. But of late that is to say for the last twenty five years we find that the Hindu customs which were found prevailing in the community are getting out of vogue. Especially, the Miana youth have been showing a great zeal and favour for the Mahomedan and all that is Mahomedan. They are now actually changing their names and surnames and wish to give up every thing which smells of Hindus and Hinduism. In dress in food in language in ideas and though even in their outlook for life they are fast inclining towards Mahomedanism. Khilafat movement and the pakistan movement have managed and that too successfully to change Hindu looking Mianas into pure and unalloyed Mahomedans. Just when they were living on the border of Cutch and Kathiawad they came across some miraculous people who helped them from time to time and so they have been respecting and honouring them as saints. Some of these Peers are Jakaria Peer, Dawalshah Shahenshah Sharman Peer Maltabshah. These are the some of the great Peers whom they respect and hold fairs on the anniversary days of those Peers. Every evening a just before the durgahs of these peers a lamp, is kindled by the Mujawar of the holy man who looks after the durgahs of the Peers. He also burns loban incense before them. Drums are beaten at the time of sunset and the people who are living near the durgah go to pay respect at the time. When the fairs are held hundreds of Mianas gather to gather from all the surrounding parts and offer their Mantas. They live together. A grand feast is arranged by the people who have gathered and the money is raised by the contribution from the Mianas. Fortunately there is no gambling to be seen in these fairs and in this respect these fairs differ from other fairs held in different parts of the province.

Miana Traits. Mianas are tall, muscular, active, fond of shooting. They are very fond of riding. They have good horses which are not only speedy but very docile, and faithful. These horses go a great distance in a day. Mianas are of unquestionable courage, uncommon intelligence and have a making of excellent soldiers. It is to be regretted that these talents have been turned into such channels and though they are not given to violence and crime as they were given a few years ago they are still considered the scourge of Kathiawad. They still bear the evil name of robbers, cattle-lifters and gang-way-robbers. They can be turned into excellent soldiers of Saurashtra. Mianas are fearless and dauntless and once they are out to do a thing they will surely achieve

it at any cost. In perseverance, patience in the point of adventure, they are unbeaten throughout Kathiawad. They are very faithful to one whom they consider their own. In service, in their faithfulness they are as good as Arabs, in reliability they have a moral code of their own. They will not rob a Brahman, a sadhu, a fakir. They will not molest a woman, a helpless person who entrusts himself to their shelter. They will not give up or forsake anyone whose salt they have tasted. But once a person has molested him or wronged a miana, he will not be able to escape vengeance. There goes a story that a particular Arab was offering his Namaj prayers. When he finished a miana asked him whom did he pray and what was his prayer ! The Arab replied that he prayed to God and he prayed to show him His mercy. The miana asked, was he afraid of Allah ? The replied in affirmative. The miana said, him go along with him to Malia there he shall not have not to fear any God. Such are mianas and when they are out to take vengeance they even set God aside. In shorts, he is not God-fearing at all.

Miani is a cause of a great mischief a miana she and contributes and has contributed to bring about ruin and destruction to the Mianas.

Occupation. The chief occupation of Mianas was agriculture. They were and can be good cultivators but the time and the circumstances have forced them to give up that peaceful occupation for a more troublesome life of trouble not only to them but to all others who are living with them. They have taken to a life of robbing and having made themselves notorious in the land but they have undergone many hardships and untold privations. When we hear what were the steps taken by the authorities to weaken them we cannot but feel to what humility they were put to. In Malia itself it was and it is still a rule that no Miana can leave the state limits unless he goes to the authorities and explains the business and if the authorities find that the cause given by him is real he issues a pass. In that case he is allowed to go out and he has to return before the fixed period specified in the pass. If he goes out of the state limit without a pass the police of the place where he is found arrests him and charges him with some crime or the other and prosecutes him and sentences him to rigorous imprisonment for no fault of his and the state authorities of Malia sentences him to a separate punishment. If a Miana is going out for five years and he is never taken to the court for any offence the state authorities of Malia issues out a permanent pass so that he can go and move about anywhere he likes. With even such restrictions these Mianas were more than a match for the authorities. The Government of Saurashtra will do well to raise and to date police force and a first rate regiment from these Mianas and take the fullest advantage of their gifts used after their usual high way robberies without any fear of being caught or arrested. Their presence was usually marked at 9 p. m. and the next presence was marked early in the morning at 6 a. m. the authorities were quite sure that these Mianas will not be able to escape during night but they were always mistaken in their calculations. These Mianas used to leave Malia limits after their presence was marked they used to ride their horses and were back before 6 a. m. next morning they were robbing people one hundred miles away from Malia. That is to say they used to cover a distance of two hundred miles under the cover of a night and before the early morning presence was checked, these robbers were in their respective houses. The fact to be taken into con-

sideration is this that these people used to travel so far committed robbery, return the same distance and after that they used to go somewhere in the Rann area and conceal the property they had deprived and then return to their homes and wait for the specified time that is to say 6 a.m. With the speed of the lightning they used to go on their business and with the same speed they used to return without being detected. This is really wonderful. One of my informants a Miana now running his seventy-eight year told me a story of his youth that he had himself covered on foot a distance of forty-eight miles in the course of three hours on foot and he showed to me a certificate of the then Political Agent to the effect that the said Miana had struck him with wonder by covering a distance of forty-eight miles in three hours. What a speed and what a wonderful power to undergo a fatigue? There are instances in which these Mianas have robbed great and wealthy men and given away the loot to feed and the clothe poor men. On one hand they will rob a village and just on the other hand they will feed the Brahmans and the poor people of the village. What sort of equalisation of wealth and the people should be considered and looked upon as real heroes for they always stood by the poor people of the land and were always ready to help them. When these Mianas by some chance come across some poor and pitiable fellow and when they tried to loot him they knowing the real fear of things the real state of affairs they all of a sudden used to come to themselves and they used to realise that they were about to loot a pitiable fellow they not only spared him but they used to give them the food and the clothes and some money to spend on the journey and what was more that they used to see the man reaching his destination safely. These traits are the traits which are not only notable but very highly commendable. They are outspoken people and they do not stand on formalities. They will call a man whoever he may be in a villager's way that is to say without showing any respect towards and taking his high position into his consideration. So a Brahman, a sadhu and a chief of some place or even the king of a kingdom will be addressed by him in one and the same way. And those who have come in their contact will never consider it an insult if they were addressed in the simple and sincere manner. People say that not only that they use a lance or a sword but they carry such swords in their tongues. He would care to say they call a spade, a spade without standing on any formalities or without fearing anybody. He does not believe in the charm of soft and sweet words.

They do not prosper so much in agriculture. However, they have now taken seriously to agriculture. Others have taken to labour, service and service especially in police line. There are others who have left their native places and settled in towns like Viramgam and Ahmedabad. They are said to be experts in mechanics and there follows those who have taken to this life they have shown their intelligence in this department of life. Mianas make excellent technicians. In many mills of Ahmedabad these Mianas have gone up to very high posts and they are getting good salary.

Farmers coal makers. Owing to the persecution from all quarters and owing to spread of new ideas and owing to realising that the old though bold ways of robbing and looting villages and harassing people to be harassed by others is on the whole an unhonourable business and at the same time not a paying business. They have with the changing of time

change their ideas and life. This has at last been understood by these people. So it must be said to the credit of these changed times that a community so highly criminal and dangerous has at last come round and is still coming round and trying to be an honest and honourable unit in the society. They are settling down as peaceful farmers and when they take to it sincerely they are bound to be hard working farmers. They are improving the land they plough and reaping good crops along with other farmers. Comparative penury to which they are driven also has played its part in inducing them to take to other fields of earning their bread. In Malia and in other surrounding villages these Mianas have found out a very good business. It is said that when some fifty years back the river Machhu was heavily flooded due to excessive rainfall seeds of wild Bawal trees were dragged along with the flood. These seeds have been wildly spread from Wadhwan side to Morvi side and Malia side. In short all over Zalawad these seeds have been spread by nature and by the wild growth of the tree and its capacity of spreading its wild growth. This kind of Bawal is a kind of tree that when it is burnt it yields good coal. So these Mianas have taken it as their business to make coal out of these Bawal trees. It is a very paying business. They have got a knack of burning the tree in a particular way and making coal out of the tree. This coal is very good for cooking purposes and there are certain factories which use this kind of coal in their daily coal consumption. It is said that this coal is cheaper and easily available by its being at hand and so easily available. These Mianas make coal and go out or send their men to sell the cartloads of coal in the adjoining towns where they get a ready market. These people go to towns situated fifty or sixty miles away from the place where this coal is made.

Mechanics. There are other Mianas who have taken to a life of a mechanic. Being good mechanics they start flour mills, saw mills, motor repair works and so on. Whatever they take up they are always able to make it a success because they are gifted physically and mentally too they are up to the mark. When we come across Mianas in a town like Viramgam or Ahmedabad we cannot easily recognise them for they have been so much with the time in their dress and manners. So with the opening of new vistas in life only old men and others who have some natural difficulties or handicaps stick to their native places while the young and the sound bodied go out and make their way in life.

Fishermen. Mianas being Mahomadans have no objections to taking meat. Naturally they have no scruples to any kind of business in which 'Himsa' is involved. Living in the neighbourhood of sea they have as all other people living in the neighbourhood of sea have done taken to fishing business. So the Mianas are fishermen. Living by the side of the sea and living in small fishing villages they are carrying on this trade for the last so many years. A kind of fish called 'Sonaiya' is found in the vicinity of Malia. The Mianas go out to the sea and catching them in large numbers export 'Sonaiya.' All the northern coast of Kathiawad is sprinkled with small villages wherein Mianas eke out their livelihood by fishing. Such Mianas are found westwards upto Dwarka and Okha. In all villages westward of Morbi say Malia Balambha Jodiya, Bedi, Jamnagar, Sachana, Sikkam, Sarmat, Varinal, Bharana, Salaya, Dwarka and Okha we find Mianas carrying on a flourishing fishing business and exporting fish in the adjoining towns. But we must say that the States

concerned have been not so much interested in this trade as they ought to be interested. Their eyes and their attention are directed in other directions but it is high time now to wake up and pay all the possible attention and encouragement to this trade which bids fair to be one of the very paying coastal trade. Kathiawad is naturally at an advantage in having sea coast all round it and this is the advantage which no other part of India or province of India has got. Naturally, the fishing trade if properly encouraged through Mianas and other fishermen of Kathiawad, it is bound to repay more than the labours and care spent on it. The communities such as of Mianas and other communities will be prosperous and it will add to the wealth of the people as well of the whole Saurashtra. Looking to the existing circumstances one will like to suggest that there is no reason why a survey of the Kathiawad coast from the standpoint of fisheries be made through experts by the Saurashtra and a training should be introduced through some fishing schools so that the trade may be improved to pay greater returns. Mianas will surely lead the fishermen of Saurashtra.

Sea Captains. Over and above this fishing business the Mianas are actually working as sea captains and sailors on country crafts for the last hundreds of years. They are plying ships on the Western coast of India, Arabia, Persia, Baghdad and Basara in Turkey that is to say in the Persian Gulf but they are quite at home in the Arabian Sea and Indian Ocean. They are found plying their ships upto African ports such as Mombasa, Zanzibar and so on. They have been very clever sailors and they manage ships in a far better way than many other trained people because they are the children of the sea and have been going out to see from their very childhood. They begin with the fishing business and then when the boys are aged enough to go. The government of Saurashtra should open schools on the coast line and train these born fishermen and sailors and add to the wealth of Saurashtra, work on the sea they begin with the lowest ladder. They begin with working as an errand boy and is entrusted with higher type of work as he shows the necessary pluck and tact. The local merchants engage them for a trip and settle what is to be paid to them with the captain and that man engages other Mianas of his confidence and gives their names to the merchant. These servants as they are engaged are paid for their services before they start on a voyage. They are not allowed to carry on any trade on their own account. The food and the other necessities of life are paid for by the merchant who engages them. They tranship a cargo from the port and hand it over to the merchant whose address is given to the captain of the ship. In this field too they rise to a very high position. They are distinguished sailors and they prove of great value to the businessmen by their obedience and faithfulness.

Nature and Dress. Mianas put on a sort of a Lengha with tight grip at the lower end and very loose from the part near waist. They put on a short half coat. Formerly they used to put on a country coat without buttons but with many strings to keep it tight and fitting round the chest. They tie a peculiar type of turban a mixture of morbi type with cutchhi type. Mianas put on a petty coat, a blouse with the back open and having laces to keep it tight from the back. They put on a sadi on their heads. The way in which they put on sadi is very peculiar i.e. it resembles the way of Girasanis or Rajputanis. The way in which they wear it throwing a

loose end of the sadi on her shoulder gives her a very graceful appearance. Her stalwart body, her beautiful features, her bearing and her fearless spirit equal to any occasion cannot but make any one admire her. A Miani is a very fine specimen of womanhood but for her some what loose character she would have served as a fine model to woman life of a Miana. Miana is generally a pleasure loving fellow of a jovial nature. He is frank and open hearted. So he does not like to earn his living by the sweat of his brow. He therefore finds out the ways and ways by which he can live happily. It was due to this that in the beginning they gave up agriculture for it did not suit their blood which was and still is full of ferver for outdoor life, a life of risk and adventure, life in which they can show their daring spirit and natural boldness. So the arms and their chivalry have a special and natural fascination for them. They say that they were driven to the recourse to arms and how they used them to the great credit. But with the changing of time they have been settling down to peaceful agriculture, fishing and sea faring life. However they are hard working and tactful. They get up in the morning and just after doing the round of their morning duties go to work in the field or to catch fish from the sea. In that case they start for their fields with plough and other implements of agriculture accompanied by their bullocks and carts. In the second case they go out with their fishing nets and spread them in the sea and catch fish whatever they can get. For the whole day they are busy. In case they make coal from Bawal trees they are after arranging the Bawal and burning them so as to yield them good quality of coal. Those who are working on a ship are busy that way. But whenever they are free from their daily routine they gather together in the chora of a village smoking bidis and chatting with friends and relatives sitting on the sides of the main road on planks of wood just attached to shops.

Economic Condition. Economically Mianas are not better. Owing to the days of hardship and persecution from all quarters they were required to defend themselves from these enemies at the cost of life and every thing. Naturally, they can hardly be prosperous. When they were in constant danger being attacked and arrested and blown off from the mouth of canon. But after this period they have taken to peaceful life and settled down to agriculture, fishing, coal making and sea farinf g life. The result that they are not able to maintain themselves with difficulty. But there is every hope that they will be getting better economically in thet imes to come. They are at present poor people and struggling to make an escape from poverty.

Language. With regard to their language we can say that Mianas speak Gujarati language but this Gujarati language has an admixture of Cutchhidialect. The reason of this is quite simple and it is that the yare living on the boundary line of Cutch and Kathiawad. One thing more and it is that they have come and settled in Kathiawad from Cutch. Conclusion after making a social study of the Mianas we cannot help saying that the Mianas were and are bold and brave people fearless and dauntless. They if properly handled would have formed an invincible army in Kathiawad to defend her and to protect her in the troublesome time through which she had to pass before the company came and settled the disorders by establishing a Kothi at Rajkot. They could have been excellent fishermen if properly trained and would have added to the wealth of

Kathiawad. As sailors if they would have been well encouraged they would have made Kathiawad very very strong at sea. Not only this but they would have helped Kathiawad to have a fleet of merchant ships. It is a pity that Kathiawad and Kathiawadis have allowed such a golden opportunity to slip away from their hands. They could not appreciate the God-given gift, they threw it away calling it a curse, persecuted and crushed the brave people who could have a cause of their pride. The brave people have been crushed. There are no more real Mianas to be found, what we come across is not the substance but a shadow. Let us wish that before these people merge into a masses we wake up from our sleep and make the problems of turn people to our best account by encouraging them in the fisheries, encouraging them to be our best sailors a turn out to be very good mechanics and last but not the least good agriculturists and cattle breeders. What they want is sympathy and encouragement. If this is guaranteed of then are sure to make a worthy citizens and very useful members to our society. With the required education and a sort of good training in their vocations they will repay efforts made by our Saurashtra government.

I am sincerely thankful to the University of Bombay for giving me financial help to carry out this piece of research.

1

A song supposed to be sung by the bride and addressed to her grandfather. Oh my grandfather hears that the bride says to her and then replies to her question.

O grandfather look here some right royal prince has come to visit our village
 Dear, O grandfather, the drums are beaten and pipes played.
 Is he not right a royal prince ?
 Come right royal prince to pay a visit to our village.
 No. O my darling, it is the son of Raysingbhai
 He is Allarakha, who has come to celebrate marriage with my darling,
 with my sweet sweet darling.

2

The bride is supposed to sing this song to her mother being enraptured after seeing her future husband.

Mother, hast thou seen a heavenly prince ?
 The prince who comes to-day to our village ?
 She is more handsome then words can describe him,
 He is more wise than one can show in words.
 Look at his dress and the style of putting it on.
 Does it not make one think and pause to gaze at him ?
 More I gaze at him more I go mad.
 Mother, dost thou know who he is ?
 Not very tall not very stunted,
 Not very fat not very thin,
 Not very sharp, not very dull such a bridegroom
 Such a bridegroom my friend has praised
 Dost not thou also prefer such a bridegroom and admire ?

3

A song sung by women of the bridegroom's side while the marriage procession has started.

Ride slowly ride slowly my brother
 See, that the horse may not stumble.
 The horse may not give you a jerk.
 We shall soon reach the house of the bride
 We shall enjoy to our heart's content
 Sugar with soft well leavened buns,
 Ride slowly, ride slowly, brother
 It has not become very late we have a good time
 A good time is before us.
 We shall reach the marriage booth
 To enjoy beetle nut and beetle leaf.

4

A song sung by the women of the bridegroom's side when the procession is on its way to the marriage booth.

The elephants of Kalubha go hanging their trunks
 Respectfully on the best of the elephants is seated the handsome Jasabhai
 the bridegroom
 The kings of great kingdoms walk on foot
 To adorn the procession. The Maharajas attend the procession.
 How the elephants hang their heads majestically.

5

A song sung by the women of the bridegroom's side.

Punja vevai was thirsty and wanted water to drink.
 His wife would not offer him water to drink
 There was a quarrel between the husband and the wife.
 Mithi vevan gave him a sound thrashing.
 Where can the poor man go? Our Lakhabhai gave him his protection and
 he offered his daughter to our Mulubhai.

6

A song sung by the women of the bridegroom's party to the bride.

O black cuckoo, thou art appearing at thy best
 When thou art singing thy song. Come to our country.
 In our country there are mango groves,
 Come there and sing thy song.
 There are best fruits and foliage.
 Come there and sing thy song.
 There are best lakes and ponds
 Come there and sing thy songs.
 The nature smiles there all times,
 Come there and sing thy song.
 Our country is beautiful and thou art beautiful.
 Cuckoo, O sweet cuckoo come and sing there thy songs.

7

A song sung by the women of the bridegroom's party in Fuleaka.

We looked at the banyan tree and the clouds of the sky
 And lo lower appeared the clouds.
 And higher far higher appeared the banyan tree.
 We looked at the Himalaya and the hillock
 The hillock appeared higher and the Himalaya lowly
 We looked at Gods and men
 The man appeared greater and the god appeared smaller.
 We looked at the bride's father Veerabhai and Hajibhai
 the father of the bridegroom.
 And lo, Veerabhai looked humble and Hajibhai great.
 And Veerabhai looked poor and Hajibhai rich.
 And lo Veerabhai was found defeated and Hajibhai victorious.

8

A song sung by the women of both the sides when they apply yellow paste to the body of the bride and the bridegroom before giving him a bath.

First good offering comes to our hands
 It has come from the grandfather's durbar
 Receive it well.
 The second good offering has come to our hands
 It has come from the Kakaji's durbar
 Receive it well.
 The third good offering has come from our hands
 It has come from the Mamaji's durbar
 Receive it well.

9

A song sung by the women of the bride's side.

On a high hill is growing a tree of cardamum
 How its branches swing in the wind ?
 Honour the Maera of Jasibai.
 On a high hill grows a mango tree.
 How are its branches swing in the wind ?
 Honour the Mamera of Jasibhai.

10

A song sung by the women of the bride's side.

Sister, the Moon has risen in the sky and the Sun has set.
 I wait and wait for the arrival of my brother.
 He has not come to join me in the celebration of Rupibai
 Sister, Night is far advanced I think he must have forgotten me
 He has not come, I wait and wait for his arrival.
 Sister, my sister-in-law smiles and smiles asking me when will he
 When will your brother come ?
 I have no answer for him. He has not come, the brother
 Born of the same mother Has some work or my 'bhabhi' detained him.

11

A song sung by the women of the bridegroom's party.

O Drum beater beat thy drum slowly
 Do you not know that the bride's Father Khimabhai
 Is a very chicken hearted fellow?
 He will be frightened out of his wits.
 He will think some great emperor has been angry with him.
 He will be frightened out of his wits.
 Of course if he terribly afraid of our Parbatbhai,
 Parbatbhai the father of the bridegroom will offer him a shelter,
 But what about his poor wife and children ?
 Our Mulubhai will take them as poor creatures and protect them.

12

A song sung by the women of the bride's party.

Who have come these Bajanias ?
 Our Lakhabbhai has no time to see their show.
 Ask them to go away and find some better village.
 Who are these Bhawwayas ?
 Our Lakhabbhai has no time to see them.
 Ask them to go to some better village.
 Who are these rope dancers ?
 Our Lakhabbhai has no mind to see their shows.
 Ask them to seek some other men to please to fill their belly.
 No. No. It is not Bajanias, Bhawayas or Rope-dancers.
 Then who are they ? Inquires the great Lakhabbhai ?
 And what for have they come ?
 They are men belonging to the party of Parbatbhai
 The father of the would-be husband of Rupibai,
 O I see all them and let us celebrate the marriage of Rupibai
 With his son for they are poor. Let us show mercy to them.

13

A song sung by the women of the bride's party.

Here we have got in our harbour a ship from distant seas.
 The ship has brought clothes for our Manbai
 They have brought silver and gold for Manver
 They have brought splendid eatable for Manbai
 A ship has come in our harbour laden with rich and costly fruits
 They have brought for our Manbai
 Rich and super silk, invaluable gold and silver and wonderful
 Fruits and other juicy eatables.
 Who has sent the ship ? Harsubhai, Jasabhai and Parbatbhai
 Who knew that Rachibai's marriage is to be celebrated.

14

A song sung by the women of the bride's side.

Bring a nice necklace for our beautiful Rupibai.
 Bring for our beautifull Manbai a beautifull Zarmar.
 Bring for our beautifull Manbai a pair of gold bangles.
 Bring for our beautifull Manbai a pair of silver Kadas.
 If you want to see your son's Marriage taking place to-day
 To-day and to-day with our incomparable Manbai

15

A song sung by the women of the bride's party.

There is big big banyan tree with a numberless branches
 Now sit in the shade of the tree travellers.
 They sit, chit chat and go away their way.
 The banyan tree gives the shade and the much wanted rest
 He gives them sweet breezes of wind cooled through the leaves.
 What more can he do ?
 Travellers go away as birds to.
 As the birds fly away when they have well rested
 And then their time is up.
 Such is the case with us all. Rupibai must go away.
 When her time is up and other groves required her.



Fig. 1 - A Miana Landlord



Fig. 2--A Miana Headman



Fig. 3—A Miana Landowner



Fig. 4—A Miana Sepoy

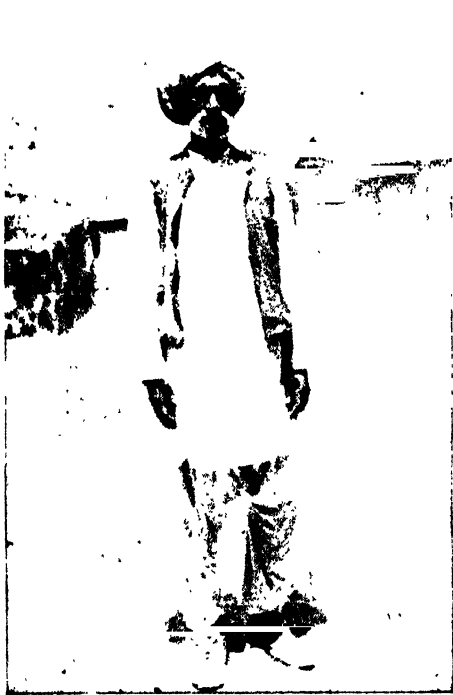


Fig. 5—A Miana Jamadar



Fig. 6—A Miana Couple



Fig. 7—A Miana Family



Fig. 8—A Miana Mother and her Children



Fig. 9—A Miana Householder



Fig. 10—A Miana Middle Aged



Fig. 11—A Miana settled down to Peaceful Life



Fig. 12—A Miana Dacoit

ABSTRACTS OF THESES

Food Crops of Gujarat

By R. G. PARIKH

THE importance of food cannot be exaggerated in a country like India where agriculture is the basic industry. To maintain the population in a healthy condition it is necessary to provide adequate food. The quality of food should also be satisfactory. The precarious food situation in India, as evidenced by the chronic malnutrition and the recent famine of 1943 gives further importance to the study of food production in India. The tremendous rise in the prices of food grains at present is an index of the acute scarcity of food grains. The food problem therefore remains colossal. The National Diet should be planned scientifically both from the point of view of quantity and quality. An intensive study of the technique of producing various nationally essential foodstuffs in the most efficient way in each region of India is the *sine qua non* of a progressive food policy. This work is an attempt in that direction. While the various regional surveys relating to the problems of agricultural economics lay more emphasis on the economic side, this thesis is a departure from the usual approach as it lays more emphasis on the technical side of the problem.

This work is based on published data and is supplemented by the firsthand information obtained during field investigation. The thesis deals exhaustively with agricultural conditions in Gujarat and the place of food crops therein. The introductory chapter deals with the past and present food position in British Gujarat. It is observed that the production of foodgrains in Gujarat amounts to 583 thousand tons, but the food requirements on a nutritional basis would amount to 830 thousand tons of cereals and pulses. This leaves a deficit of 297 thousand tons of food-grains; and this deficit is likely to widen because of the steady rise in the population of Gujarat. Moreover, the average yield per acre of foodcrops have declined from 717 lbs. in 1911 to 515 lbs. in 1941. This decline in the outturn of foodcrops indicates the deterioration of our agriculture, particularly in connection with the cultivation of foodcrops. Hence our agriculture should be so planned that all the resources may be fully developed and maximum food production achieved.

The various factors that enter into agricultural production viz. the productivity of the soils, land utilisation, climate and agricultural water supply, manures and manuring practices, tillage and technique of cultivation and crop protection are fully discussed under separate chapters. The part which these factors play in the cultivation and production of each crop is discussed in the chapters on "Food Crops". Attempts are also made to show the benefits of and the methods of utilising a commercial crop like groundnut as a food crop. The necessity of increasing the food production through the extension of cultivation of roots and tubers has also been pointed out. The qualitative aspect of food production has not been neglected. The cultivation of fruits and vegetables and the possibilities of its extension along with several problems of orchard cultivation are examined. Lastly the efforts made by the State to develop agriculture in different directions are critically analysed. The weakness in the policy of the State in relation to agriculture and the effects thereof on the entire population, particularly on the farmers and on the live stock during a large number of famines resulting from low and uncertain food production are pointed out. The need for a bold and progressive policy and a comprehensive plan with the primary object of achieving maximum production of food through the development of the various resources of Gujarat on the lines suggested is emphasised.

Beggar Problem in the City of Bombay

By P. S. SHROFF

FEW human interrelations are little known and less understood by the people than begging, but a scientific enquiry into the beggar problem has yet to be made by social scientists in our country. With the existing paucity of statistical data a comprehensive investigation into the beggar problem facing the whole country would be beyond the scope of the efforts of a solitary social worker. The present writer has therefore confined his study to urban begging only.

As an occupation begging is akin to other professions of the underworld like crime and prostitution. The sociologist who undertakes a study of begging should therefore utilize the same methods of approach which he applies to the study of these pathological problems. Put briefly, the sociologist should assume the additional role of a social worker and should correlate his knowledge of social theory with experience of social case-work. In doing this, the sociologist is within his rights if he imposes on himself limitations of time and space. The present writer has therefore chosen the city of Bombay as his area of field work.

To the casual observer and the layman the beggar may appear to be 'a nuisance', a 'a pest to gentleman', a 'human derelict' or 'a clever maligner'; but, for the sociologist begging is a familiar phase of human relationships, and a product of the social process. Most begging is due to poverty and destitution over which the individual has little or no control. Abject misery creates such vicious circles, that it is not possible for the individual to break loose from them except by begging or by crime. Apart from poverty there are various other social factors that accentuate the growth of begging in a community. These are :—

- (i) The failure of the State and institutions like the family to protect its natural dependents like the child, the old-aged persons and the widows ;
- (ii) vagrancy or the unregulated migration of casual labour, hoboos and tramps from the towns and countryside towards the cities ;
- (iii) religious mendicancy ; and
- (iv) indiscriminate almsgiving.

This thesis is mainly an investigational work ; as such it is not a mere study of books. The author moved about in the various localities of the city and interviewed a large number of beggars. The results of his personal investigations were noted down in questionnaire—papers specially prepared for the purpose. All the important conclusions in the thesis have been drawn from and substantiated by relevant case-studies and a number of illustrative photographs.

The Government of Bombay enacted the Bombay Beggars Act in 1945 and applied it to the city of Bombay in the first instance. By personal visits to the various Certified Institutions where beggars of the city are detained after arrest and conviction, a critical review of the administration and working of the Act has been given in a special chapter. In the light of Western experience regarding measures of control of begging, constructive suggestions have also been made.

It is high time that our public is reminded of the fact that the beggar problem of the city demands 'social action' more enlightened and pre-planned than small-change philanthropy. Indiscriminate almsgiving is an individual effort that can never solve a mass problem like begging.

Utopians would however do well to remember the magnitude and complexity of the problem before expecting quick results of their schemes. The solution of the beggar problem is connected with and dependent upon our efforts at the solution of interrelated issues like :—

- (i) The poverty and unemployment, especially under-employment of our teeming millions ;
- (ii) untouchability ;
- (iii) abolition of the aborigines so-called within the fold of the general population ; and
- (iv) improvement of the health standards of our people.

If private enterprise continues, until these problems are solved, begging will remain a persistent phenomenon in our social life. Eradication of begging is therefore only a goal, though it is possible and imperative that the nuisance is reduced.

In urban communities begging is a civic nuisance and a serious menace to public health. As a parasitic activity undertaken by thousands of individuals in the city its continuation involves a tremendous waste of human energy that could otherwise be utilised in increasing wealth and augmenting the welfare of the community. Now that our country is free, our popular statesmen and administrative authorities are bound to undertake schemes of planning that may improve the standard of life of our people. But these schemes should not be confined merely to the economic field. Schemes of social reform must precede our economic programmes lest the sociological bottlenecks torpedo the economic schemes. In these schemes of social reform, begging will take its due place. But before undertaking comprehensive schemes of control of begging, scientific diagnosis by survey work is necessary. As an humble beginning in this direction, the present work finds its own justification.

Renascent India

BY K. C. Vyas

IT was a surprising coincidence that no sooner was the British occupation of India on firm ground, then the forces of regeneration raised their head under the leadership of Raja Ram Mohun Roy in India in 1818. Some authors have tried to write on the subject of 'Renascent India'. They have in dealing with the subject put emphasis to a greater or lesser degree on social, political or economic forces. But hardly have any of the writers attempted to show that the forces of Renaissance started by Raja Ram Mohun Roy were carried forward by his successors. The fundamental principles and the undercurrents of the renaissance movement were only an appropriate development of the one that were started from the Raja. Indian 'Renaissance' movement started, with a great man viz., Raja Ram Mohun Roy and ended with one who is equally great, if not greater, viz. Mahatma Gandhi. Further the movement once started grew from more to more, reached its climax and achieved its goal. The leaders of the renascent India were no doubt bound to come in conflict with the forces of the West. But all along the leaders relied mainly for building the structure of regenerated India on the sound foundations of ancient Indian culture. And yet they were not isolationists. Whatever there was good in the Western culture was being adopted only after remoulding it to suit Indian atmosphere, and culture, without disturbing it. We shall not attempt to study all the aspects of Indian Renaissance, but only concentrate on Socio-Religious Movements, Social Reforms, Education, Literature and Journalism. All these factors have played their part in the regeneration of India. The part these forces played slowed down or gathered momentum according to the general tempo of the nation and other conditions then prevailing in the country. In the beginning the movement of regeneration radiated from a single centre, viz., Raja Ram Mohun Roy. Then the movement was diffused in among various leaders of renaissance, then again in the end the various forces converged in Mahatma Gandhi and radiated from him. In the socio-religious sphere there was the movement of the universal church of Raja Ram Mohun Roy with only diluted Asiatic and national pride ; under Keshav Chandra

Sen became thoroughly Asiatic conscious. Under Swami Vivekananda, the Asiatic or Eastern consciousness began to grow aggressive and in the terms of spiritual conquest of the West. Western materialism was balanced with Eastern spirituality. There was no cause to feel inferior. The contact of culture between the East and the West had to be on a footing of equality. Under the Arya Samaj this spirit of equality began to give place to the feeling of superiority of the Aryan culture and the Vedas. East was replaced and represented by the most advanced and cultured nation of the East-India. Theosophy also played in a milder way the same note of the Arya Samaj. Yet in the end the forces thus converged into narrowness and national pride, again under Mahatma Gandhi took on an universal plane of equality of all religions. In social reform, education, literature and journalism, we come across the same process of regeneration and development.

The socio-religious movements did help to irradicate certain social evils existing in the Hindu society. These movements also began to limit the sphere of social and religious institutions. Slowly the movements for secularisation of social institutions began to gather momentum. These social reform movements and social reformers began to consider and solve the social problems from sociological and secular point of view. In the end the socio-religious movements and the social-reform movements merged themselves into the growing national consciousness.

The other forces that helped the process of regeneration or renaissance in India were Literature, Education and Journalism. These three forces are very vital factors in the growth of any nation. Under the imperialism of the British the forces had to work under great handicaps. There was no atmosphere for free growth of literature. The fear of censor was no mean thing. Yet, in spite of difficulties the literature did contribute its quota towards the regeneration of the country by attacking social, economic and political problems existing in Indian society. Education had been so organised that it only helped to maintain the status quo. Yet the efforts at independent, cheap and national education by the Indian people to a great extent helped to awaken national consciousness resulting in setting free the forces of national regeneration. Journalism too, had to work under many suffocating restrictions. But it carried on its fight for freedom and at times of crisis helped the national movements. In free India, Education, Journalism and literature have to play very important and at the same time difficult role. It is for these forces to make the democracy a success.

This impact or conflict of the cultures of the East and the West was a benefit in disguise. Both the cultures are complementary to one another. The East or India had proved deep into the questions of philosophy and religion and had at its command the wisdom of ages. The other (West or England) had achieved great many things in the field of material comfort. Each by itself, the materialism of the West and the spirituality of the East was found wanting. If the West had solved the problem of want, it had miserably failed to solve the problem of peace. If the East had attained a certain poise and calm, it was living a life of scarcity. The new civilization that is developing out of this process in India, would balance the life of man both spiritual and material. This harmonious blending of East and the West in India may prove a great way towards solving the problems of the war weary world.

BOOK REVIEWS

Munir-ud-Dowlah (1695-1774) : His Life and Times. By Nawabzada Murtaza Ali Khan. Pp. 112. Hind Kitabs Ltd., Bombay, 1947. Price Rs. 6.

NAWAB MUNIR-UD-DOWLAH belonged to a noble family of Iran. He first came to India in 1735 on a diplomatic mission entrusted to him by Nadir Shah. The failure of this mission resulted in Nadir's march into India and his ruthless sack of Delhi. The writer claims on page 6 that it was at the intervention of Munir-ud-daulah (or Reza Quli Khan as he then was) that Nadir Shah put a stop to the merciless massacre of the innocents of Delhi. There is no historical evidence in support of this claim except the tenuous and second-hand statement of Keene that the massacre was stopped by Nadir "on the supplication of his own minister." The reviewer wonders how this has enabled the writer to discover that the minister was Reza Quli Khan. The page reference to Keene's book "The Turks in India" is incorrect. This may be a printer's error, but the Siyar reference in footnote 12 on page 14 and the Franklin reference in footnote 13 on the same page are not amenable to verification. These are some of the many minor (?) but irritating inaccuracies in the book. Of course the book has its major inaccuracies also. These have been dealt with in subsequent paragraphs.

When Nadir Shah returned to Iran, Reza Quli Khan stayed on at the Mughal Court, though in what capacity it is not clear. He soon made for himself a place at the Delhi Court and after the assassination of Nadir Shah he seems to have entered the service of Intizam-ud-daulah, son of Qamruddin Khan, the Prime Minister of Muhammad Shah, as superintendent of his war equipage.¹ When a contemporary writer who was also attached to the Mughal Court (Syed Ghulam Ali Khan, the author of *Siyar-ul-Mutakherin*) makes this statement, one fails to understand why the author fights shy of it. He vaguely mentions on page 7 that Reza Quli Khan "became attached to the Court in what capacity it is not known."

The critical reader, who is familiar with the later Mughal period and with the achievements of Munir-ud-daulah as a diplomat, would certainly like to know on what authority the author states (pp. 1, 7) that Munir-ud-daulah was a minister to Ahmed Shah (1748-1754) and Alamgir II (1754-1759). He further states on the very first page of the book that Munir-ud-daulah was also Chief Minister to Shah Alam (1760-71). The reviewer regrets to note that these claims appear to be exaggerated. Soon after Shah Alam came to the throne, he nominated Shuja-ud-daulah as his vazir, though the robes of office were not given to him till February 1762. At the same time Munir-ud-daulah was appointed "Lord High Steward and Dewan of Tan (assigned lands) and Khalsa (crown-lands)."² Both Franklin, whom the author quite often misquotes, and Ghulam Ali Khan, contemporary writers, state that Munir-ud-daulah was a minister of Shah Alam, not his Chief Minister. On the evidence of the Calendar of Persian Correspondence, we know that in 1763 and 1764 Munir-ud-daulah was the Steward of the Royal Household (Khan-i-Saman) and as such we may agree that he had the rank of a minister, but certainly not chief minister. And the writer gives no evidence in support of his claim that Munir-ud-daulah was a minister to Shah Alam's two predecessors.

There is no doubt that for a time between 1766 and 1768 Munir had been able to keep all power in his hands though Shuja was nominally the Vazir. The story of the rivalry between Shuja and Munir, how each wanted to win over the English to his cause, how Munir established himself in royal favour at Allahabad, how he incurred Imperial displeasure and how the English finally composed the rivalry between Shuja and Munir can be read in original in Volume II of the Calendar of Persian Correspondence and in that fine study of Srivastava (in two volumes) on Shuja-ud-daulah. It is a pity the author has not made fruitful use of the former and doesn't seem to have consulted

¹ *Siyar-ul-Mutakherin* II, 288.

² Srivastava : *Shuja-ud-daulah*, Vol. I, pp. 141-142.

³ C. P. C. I, letter 1967, p. 258, letter 1978, p. 263, letter 2474, p. 358 fn.

the latter. Nor does he seem to have seen Chatterji's "Verelst's rule in India" and Sarkar's "Fall of the Mughal Empire," serious omissions for a biographer of Munir-ud-daulah.

If on the one hand the author apparently has not consulted some of the more important published material, on the other some of the material utilised has been handled in a most uncritical manner and has been forced to yield totally unwarranted conclusions. On page 4 the author states that Reza Quli Khan (Munir-ud-daulah) "was sent to the Court of Sultan Mahmud V of Turkey on an embassy by Nadir." This statement he evidently makes on the strength of a Persian translation of Malcolm's "History of Persia". The original book (1st. Ed. 1815) states that an envoy was sent⁴ and adds a footnote giving the name of the envoy as Reza Quli. Now about 1730 there were many noblemen at the Persian Court bearing this name and Lockhart in his definitive life of Nadirshah, based on contemporary sources, tells us that this Reza Quli was a member of the Shamlu Clan. Reza Quli (Munir-ud-daulah) according to his descendent and biographer, the author of the book under review, was a member of the Ustajlu clan. How then and on what unimpeachable authority does our author jump to the conclusion that the envoy Reza Quli was his ancestor? Moreover on his own admission, the Shamlus were on inimical terms with the Ustajlus. The author, therefore, ought to think twice before making such daring statements and acknowledging an enemy of his ancestors as his ancestor! Or he must refute the original authorities of Lockhart!!

This is one of the many diverting ways in which the author has mishandled his theme. He sometimes omits vital sentences from quotations and attempts to mislead the reader into drawing vitiated or faulty conclusions. For instance on page 39, quoting (from Calendar of Persian Correspondence Vol. II) about the new plan settled by Lord Clive, he quietly omits a significant sentence "Munir-ud-daulah was the originator of this plan." On page 80 the author blandly asserts that Munir-ud-daulah was awarded the *Nizam* (governorship) of Kora and Allahabad on the strength of a misquotation, "On the 2nd May, Nawab Munir-ud-daulah was appointed *Nazim* of Allahabad and Kora." Munir-ud-daulah was really appointed *Naib*, but the author has substituted the word *Nazim* for *Naib*!! What actually happened was that "the Emperor was pleased to appoint the Vazir (Shuja) governor of the districts of Allahabad and Kora... while Munir was the same day appointed the Vazir's deputy in Allahabad and Kora."⁵

Munir-ud-daulah was undoubtedly an important person during the later Mughal days. But he was at best a polished emissary for making good terms with the English or a useful diplomat in negotiating with Ahmadshah Abdali. In this connection it must be mentioned that Chapter VI of the book dealing with Munir's negotiations with the Durrani king, based entirely on Vol. II of Calendar of Persian Correspondence, is readable and without blemish. But the same cannot be said of the rest of the book.

The illustrations in the book are good and the writer has also included photographic reproductions of some original documents. The printing and general get up of the book are pleasing, but the price (Rs. 6/-) seems to be too high.

—P. M. J.

Essays on British Policy Towards Sind by C. L. Mariwala, Published June 1947, pages 117.

THIS collection of five 'essays' is really a running account of British policy towards Sind during the early years of the Nineteenth Century preceding the outbreak of the First Afghan War in 1839. The author, formerly an Assistant Professor of History at the D. J. Sind College, Karachi, has taken considerable pains to make a first hand study of several British records—some of them not published—not hitherto made use of and has succeeded in presenting a consistent and readable account of the events of that period. His work is to be commended for its objectivity, restraint and grip over detail. There is no attempt at philosophising and very few historical generalisations have been hazarded. The book has therefore the supreme merit of offering a factual survey relieved only by the author's love for personal detail which makes for lively presentation.

—N. S. PARDASANI

⁴ Vol. II, p. 52.

⁵ Pp. 43, 48.

⁶ Srivastava : Shuja-ud-daulah, Vol. II, p. 168. cf. Also C. P. C. IV, letter 272, p. 53.

LIST OF THESES

Table showing M.A. and Ph.D. Graduates in History, Economics, Sociology and Agricultural Economics from 1st July to 31st December 1948, with the title of their theses, etc.

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	<i>Economics</i>		
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	<i>Sociology</i>		
Vyas, K. C.	Renascent India	Professor G. S. Ghurye	U. E. S.
Wagh, M. C.	Rgvedi Desastha Brahmins of Maharashtra	Professor Mrs. Iravati Karve	D. C. P. G. R. I.
	<i>Agricultural Economics</i>		
Patil, N. P.	Marketing of Agricultural Produce (Cotton) in Gadag	Professor D. R. Gadgil	G.I.P.E.
Rau, R. S. J.	Industrial Amylases	Dr. A. Sreenivasan	U.D.C.T.

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Economic and Commercial Publications of the University of Calcutta, the—. Edited by S. C. Ghosh.

Industrial Court Reporter, the, April,—June 1948. Publication of the Directorate of Labour Information, Government of Bombay.

Labour Management Joint Committee. Publication of the Directorate of Labour Information, Government of Bombay.

Present War and Indian Industry, the, by C. B. Kapasi, B.A.

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TRISECTIBLE NUMBERS OF SIX DIGITS

BY D. R. KAPREKAR, B.Sc., S.T.C.

In my article in B. U. J., November 1938, I had described the properties of wonderful Demlo numbers in radix 10. There are in all 25 Partition numbers in radix 10 and I have described those in detail in my article in Mathematics student, Vol. VI, June 1938.

In the present article I have described wonderful Demlo numbers in radix 100 and given directions to find such numbers in radix 10.*

I. **C**ONSIDER the product of the number
01, 02, 03, 04, 05, 06, 05, 04, 03, 02, 01
with 17 36 46. This will be seen to be equal to
17 71 71 71 71 71 36 28 28 28 28 28 46 = 17 (71)₅ 36 (28)₅ 46.*
The three parts of the multiplier 17 36 46 will be seen separated in the answer. The gap between 17 and 36 is filled by 71 repeated 5 times and that between 36 and 46 is filled by 28 repeated 5 times. In this case 17 36 46 is trisected in its body.

The multiplicand given above has pairs of digits successively increasing by 1 up to 06, and then decreasing by 1 to 01.

These numbers will be called *wonderful multiplicands*. They begin on left from 01, going on increasing by 1 up to a certain maximum ≤ 99 , and then decrease till they come to 01. These will be represented by W.

The maximum reached will also be written just below the symbol W.

Thus $\overset{W}{6} = 01, 02, 03, 04, 05, 06, 05, 04, 03, 02, 01,$

and $\overset{W}{K} = 01, 02, 03, \dots, K, \dots, 03, 02, 01;$

the number of digits in $\overset{W}{K}$ is easily seen to be $2(2K-1)$.

Since every number here is expressed as a number of 2 digits, $\overset{W}{K}$ is an extension of wonderful Demlo numbers from radix 10 to radix 100.

II. The multiplier 17, 36, 46, will be called a *partition number* and will be represented by P. Since P is trisected into three parts viz. 17, 36 and 46, it is said to have the trisection property when multiplied by some suitable W, and is also called a Trisectible number.

* We use the notation $(K)_l$ to represent a number formed by writing a number K, l times, either independently or in the body of another number. $\{(K)_l\}^2$ will be represented by $(K)_l^2$.

The object of this article is to find out all such numbers like 'P' and their wonderful multiplicands 'W'.

III. We now prove that

$$(01)_k^2 = \frac{W}{K} \quad (i)$$

$$\text{For } (01)_k = 01, 01, 01, \dots, 01 \quad (2k \text{ digits})$$

$$= 01 \times (100)^{k-1} + 01 \times (100)^{k-2} + \dots + 01 \times (100) + 01$$

$$= \alpha^{k-1} + \alpha^{k-2} + \alpha^{k-3} + \dots + 1, \text{ where } \alpha = 100.$$

$$\begin{aligned} \text{Then } (01)_k^2 &= \alpha^{2k-2} + 2\alpha^{2k-3} + 3\alpha^{2k-4} + 4\alpha^{2k-5} + \dots + k\alpha^{2k-(k+1)} \\ &\quad + (k-1)\alpha^{k-2} + (k-2)\alpha^{k-3} + \dots + 3\alpha^2 + 2\alpha + 1. \\ &= (100)^{2k-2} + 2(100)^{2k-3} + \dots + k(100)^{k-1} + (k-1)(100)^{k-2} + \dots \\ &\quad + 3(100)^2 + 2(100) + 1. \\ &= 01, 02, 03, \dots, (k-1), k, (k-1), \dots, 03, 02, 01 \\ &= \frac{W}{K}. \end{aligned}$$

IV. We now show that a partition number P is given by $99 \times ab$, where a and b are expressed as numbers of 2 digits each, and such that $b \geq a + 1$ and $a + b \leq 99$. For this we first prove the following lemmas :

LEMMA I

If $A, B, C = 99 \times a, b$, where $b \geq a + 1$ and $a + b \leq 99$,
 then $A = a, B = (b - a - 1)$
 and $C = (100 - b)$

Proof: $ABC = ab \times 99$

$$\begin{aligned} &= ab \times (100 - 1) \\ &= ab00 - ab \\ &= a \times 100^2 + b \times 100 - a \times 100 - b \\ &= a \times 100^2 + (b - a - 1) \times 100 + (100 - b) \\ &= a(b - a - 1)(100 - b) \\ &= A \quad B \quad C \end{aligned}$$

$$\text{e.g. } 23, 42 \times 99 = 23, 18, 58 = 23(42 - 23 - 1)(100 - 42)$$

$$\text{and } 15, 71 \times 99 = 15, 55, 29 = 15(71 - 15 - 1)(100 - 71)$$

LEMMA II

$$\frac{W}{K} \times 99 = (01)_k (00)_k - (01)_k.$$

$$\text{For } \frac{W}{K} \times 100 = 01, 02, 03, \dots, (k-1), \quad k, (k-1), \dots, 03, 02, 01, 00$$

$$\begin{aligned} \text{and } \frac{W}{K} &= 01, 02, \dots, (k-2), (k-1), \quad k, \dots, 04, 03, 02, 01 \\ &= 01, 02, \dots, (k-2) (k-1) (k-1) (k-2), 03, 02, 01, 00 \\ &\quad + \quad \quad \quad 01, 01, \dots, 01, 01, 01, 01 \end{aligned}$$

$$\begin{aligned} \therefore \frac{W}{K} \times 99 &= \frac{W}{K} \times (100 - 1) \\ &= 01, 01, 01, \dots 01, 01, 00, 00, \dots 00 - (01)_k \\ &= (01)_k (00)_k - (01)_k \quad \text{Q. E. D.} \end{aligned}$$

$$\begin{aligned} \text{e.g. } W_4 \times 99 &= 01, 02, 03, 04, 03, 02, 01 \times 99 \\ &= 01, 01, 01, 01, 00, 00, 00, 00, - 01, 01, 01, 01 \\ &= (01)_4 (00)_4 - (01)_4 = (01)_4 \{100^4 - 1\} \end{aligned}$$

LEMMA III

$$(01)_k \times a, b = a, (D)_{k-1}, b,$$

where $D = a + b$,
a, b being expressed
as numbers of 2 digits.

This follows immediately.

$$\begin{aligned} \text{For } (01)_k \times a, b &= (a)_k 00 + (b)_k \\ &= a, (a+b)_{k-1}, b \\ &= a, (D)_{k-1}, b. \quad \text{Q. E. D.} \end{aligned}$$

$$\text{e.g. } (01)_7 \times 53, 21 = 53, (74)_6, 21.$$

V.

THEOREM I

When $99 \times ab = A, B, C$

$$A, B, C \times \frac{W}{K} = A (D)_{k-1} B (99-D)_{k-1} C$$

where $D = a + b \leq 99$ and $b \geq a + 1$.

Proof— $\frac{W}{K} \times A, B, C.$

$$= \frac{W}{K} \times 99 \times ab$$

$$= \{ (01)_k (00)_k - (01)_k \} \times a, b \dots \dots \dots \text{by Lemma II}$$

$$= a (D)_{k-1} b (00)_k - a (D)_{k-1} b \dots \dots \dots \text{by Lemma III}$$

$$= a (D)_{k-1} (b-1) (99)_k + 1 - a (D)_{k-1} b$$

$$= a (D)_{k-1} (b-a-1) (99-D)_{k-1} (99-b) + 1$$

$$= a (D)_{k-1} (b-a-1) (99-D)_{k-1} (100-b)$$

$$= A (D)_{k-1} B (99-D)_{k-1} C, \dots \dots \dots \text{by Lemma I}$$

Q. E. D.

Thus A, B, and C are separated and the gap between A and B is filled $(D)_{k-1}$ and that between B and C is filled by $(99-D)_{k-1}$, and the sum of the two gap fillers is equal to 99.

In other words A, B, C = $99 \times a$, b is a partition number P.

VI. Now we obtain the exact number of numbers like P. This can be determined by noting that $a+b \leq 99$ and $b \geq a+1$.

THEOREM II

In radix 100, there are only 2,500 trisectible numbers and they can be arranged in 50 different groups.

Proof—This counting to 2,500 can be done by making two columns, one for a and other for b . As $a+b$ is to be less than or equal to 99 it is clear that values in table a will go on increasing from 0 to 49 and that in table b will go on decreasing.

The third column gives the exact number possible according to the values of a and b .

Table of factors a , b of trisectible numbers

a	b	Total numbers
0	01 to 99	99
01	02 to 98	97
02	03 to 97	95
.....
25	26 to 74	49
.....
46	47 to 53	7
47	48 to 52	5
48	49 to 51	3
49	50	1
Grand total..	.. .. .	.. 2500

Thus there are in all 2,500 trisectible numbers in radix 100 and theorem II is proved.

The method can be similarly extended to radix 1,000 or 10^3 and still further to radix 10^n .

It will be seen generally that in radix 10^n there will be $25 \times n^2$ trisectible numbers.

ON THE ARBITRARY CONSTANTS IN THE SOLUTION OF SIMULTANEOUS LINEAR DIFFERENTIAL EQUATIONS

By S. G. GHURYE, M.Sc.

(Communicated By Professor G. V. Bhagwat, M.A.)

(I) **W**HEN a set of n linear differential equations with constant coefficients in n dependent variables and one independent variable is solved, the general solution contains n sets of arbitrary constants, which are not all independent. The special case $n=2$ has been considered in detail by Forsyth [1], and the relations between the arbitrary constants have been derived. It is here proposed to point out how these relations are not always the correct ones and to consider the cases in which they may not hold. (The same applies to systems of equations in which $n > 2$).

Let t be the independent variable and x, y the dependent variables. Let $D \equiv \frac{d}{dt}$ and f_1, ϕ_1, f_2, ϕ_2 be polynomials with constant coefficients and T_1, T_2 any functions of t . The equations are

$$f_1(D)x + \phi_1(D)y = T_1 \text{ ----- (1)}$$

$$f_2(D)x + \phi_2(D)y = T_2 \text{ ----- (2)}$$

Solving for x , we have

$$\{f_1(D)\phi_2(D) - f_2(D)\phi_1(D)\}x = \phi_2(D)T_1 - \phi_1(D)T_2$$

i.e., $F(D)x = \phi_2(D)T_1 - \phi_1(D)T_2 \text{ ----- (3)}$

The solution is $x = X + P$, where X is the complementary function and P a particular integral $= \frac{1}{F(D)}\{\phi_2(D)T_1 - \phi_1(D)T_2\} \text{ ----- (4)}$

If $F(D) = 0$ has distinct roots λ_i ,

Then $X = \sum A_i e^{\lambda_i t}$, the A 's being arbitrary constants.

If r roots are equal to λ_1 , the corresponding part of X is

$$(A_1 + A_2 t + \dots + A_r t^{r-1}) e^{\lambda_1 t}$$

Similarly for y , we have

$$F(D)y = \{f_1(D)T_2 - f_2(D)T_1\}, \text{ ----- (5)}$$

the solution of which is $y = Y + Q$,

where $Q = \frac{1}{F(D)}\{f_1(D)T_2 - f_2(D)T_1\}$

and \mathcal{Y} is the same as \mathcal{X} except that the arbitrary constants are different, denoted by B_i instead of A_i .

As usual, the expressions for P, Q are understood to contain only such terms as do not already occur in \mathcal{X}, \mathcal{Y} .

The relations between the A 's and B 's are obtained by substituting for x, y in any of the equations (1), (2), say in the first. At this stage, Forsyth makes the statement that on substituting in (1), "the terms arising from P and Q , which are particular integrals, give on the left-hand side a term T_1 cancelling with that on the right-hand side" {p. 311 of ref. [1]}. This leads to homogeneous linear relations of the type $A_i f_1(\lambda_i) + B_i \phi_1(\lambda_i) = 0$, ----- (6) corresponding to a non-repeated root. (B) on p. 314 of ref. [1].

On substituting in (1) for x and y , we have

$$f_1(D) X + \phi_1(D) Y + R = 0, \text{ ----- (7)}$$

$$\text{where } R = f_1(D) P + \phi_1(D) Q - T_1. \text{ ----- (8)}$$

The above statement signifies that $R = 0$; but this is not always so, as is shown in section (II). Since \mathcal{X} and \mathcal{Y} both contribute to equation (7) the same types of terms, it is evident that if R does not vanish identically, it must consist of terms of types which constitute the complementary function \mathcal{X} or \mathcal{Y} .

(II) Now, let λ be any root of $F(D) = 0$, and for generality, let us take it to be an r -multiple root, so that

$$F(D) \equiv (D - \lambda)^r G(D), \text{ where } G(\lambda) \neq 0$$

Then we have two cases according as

$$\begin{aligned} & \text{(i) } T_1 \text{ or } T_2 \text{ contains } e^{\lambda t} \\ & \text{or (ii) neither } T_1 \text{ nor } T_2 \text{ contains } e^{\lambda t}. \end{aligned}$$

From the nature of the operations which result in R , it is evident that in case (ii), R cannot contain any terms $t^i e^{\lambda t}$ ($i \leq r - 1$) which satisfy the equation $F(D) R = 0$.

\therefore In case (ii) $R \equiv 0$, and the relations between the constants are homogeneous as in (6).

Thus, we need only consider case (i). The case in which $e^{\lambda t}$ occurs in T_1, T_2 not multiplied by any function is treated in detail in (a), and the more general case in which T_1, T_2 contain terms of the type $V e^{\lambda t}$, where V is some function of t is considered in (b).

(a) For simplicity, let $T_1 = e^{\lambda t}, T_2 = 0$.

The part of \mathcal{X} corresponding to λ is $(A_1 + A_2 t + \dots + A_r t^{r-1}) e^{\lambda t}$

„ „ „ \mathcal{Y} „ „ „ $(B_1 + B_2 t + \dots + B_r t^{r-1}) e^{\lambda t}$

$$P = \frac{1}{(D-\lambda)^r G(D)} \phi_2(D) e^{\lambda t} = \frac{\phi_2(\lambda)}{G(\lambda)} \frac{e^{\lambda t} t^r}{r!}$$

$$\text{and } Q = -\frac{f_2(\lambda)}{G(\lambda)} \frac{e^{\lambda t} t^r}{r!}.$$

$$\begin{aligned} \therefore R &= \frac{e^{\lambda t}}{G(\lambda) r!} \{ \phi_2(\lambda) f_1(D+\lambda) - f_2(\lambda) \phi_1(D+\lambda) \} t - e^{\lambda t} \\ &= \frac{e^{\lambda t}}{G(\lambda) r!} \left[\sum_{i=0}^m \{ \phi_2(\lambda) f_1^{(i)}(\lambda) - f_2(\lambda) \phi_1^{(i)}(\lambda) \} \frac{D^i}{i!} \right] t - e^{\lambda t} \end{aligned}$$

where $f_1^{(i)}(\lambda) = \frac{d^i}{d\lambda^i} f_1(\lambda)$, etc., m being the highest power of D in $f_1(D)$, $\phi_1(D)$;

$$\text{i.e., } R = e^{\lambda t} \{ -1 + c_1 + c_2 t + \dots + c_r t^{r-1} \},$$

$$\text{where } c_i = \frac{\phi_2 f_1^{(r-i+1)} - f_2 \phi_1^{(r-i+1)}}{(r-i+1)! (i-1)! G(\lambda)}.$$

Hence, if $c_1 = 1$, $0 = c_2 = c_3 = \dots = c_r$, then $R = 0$ and the arbitrary constants are connected by homogeneous linear equations as in (6). ----- (9) But otherwise, $R \neq 0$ and the c 's enter into the relations between the A 's and B 's. On equating to zero the coefficient of t^{i-1} in (7) we obtain an equation linear in A 's, B 's and c_i , and not a homogeneous equation as in (6).

(b) When T_1, T_2 contain terms of the type $V e^{\lambda t}$, we find from (8) that R will not be identically zero if V is a polynomial in t .

Thus, corresponding to $T_1 = t^m e^{\lambda t}$ and $T_2 = 0$, ($m > 0$), we have $P = e^{\lambda t} \frac{1}{D^r G(D+\lambda)} \phi_2(D+\lambda) t^m = e^{\lambda t} V_1$,
where V_1 is a polynomial in t .

Similarly Q , and from (8) it is seen that R will, in general, consist of terms $t^i e^{\lambda t}$, ($0 \leq i \leq r-1$), whose coefficients will enter into the relations between the arbitrary constants.

Thus we see that if T_1, T_2 contain terms of the form $V e^{\lambda t}$, where V is a polynomial in t (or a constant) and λ is a root of $F(\lambda) = 0$, then the relations between the arbitrary constants may not be homogeneous as in (6), and will have to be obtained by substituting for x, y their full expressions $X+P$ and $Y+Q$ respectively.

(III) Some numerical examples, which I have constructed to illustrate the points made above, are given below.

$$\begin{aligned} \text{(i)} \quad & (D+3)x - y = e^{-t} + t, \\ & \& \quad 2x + Dy = e^{-2t} \end{aligned}$$

This is an illustration of (a).

Here, $F(D) = (D+1)(D+2)$,

$$X = A_1 e^{-t} + A_2 e^{-2t}, \quad Y = B_1 e^{-t} + B_2 e^{-2t},$$

$$P = -te^{-t} + \frac{1}{2} - te^{-2t}, \quad \text{and } Q = -2te^{-t} - t + \frac{3}{2} - te^{-2t}.$$

Substituting for x, y in the second equation, we obtain the relations $2A_1 - B_1 - 2 = 0$ and $A_2 - B_2 - 1 = 0$, whereas according to (6) we should have had $2A_1 - B_1 = 0$ and $A_2 - B_2 = 0$.

$$(ii) \quad (D-1)x + (D-2)y = e^{-2t}, \\ \& \quad -3(D+1)x + D^2y = 0.$$

This is the special case (9) of (a).

Here, $F(D) = (D+2)(D^2-3)$,

$$X = A_1 e^{-2t} + A_2 e^{-\sqrt{3}t} + A_3 e^{\sqrt{3}t}, \quad Y = B_1 e^{-2t} + B_2 e^{-\sqrt{3}t} + B_3 e^{\sqrt{3}t},$$

$$P = 4te^{-2t} \quad \text{and } Q = -3te^{-2t}.$$

On substitution in either equation, we obtain

$$3A_1 + 4B_1 = 0, \quad (\sqrt{3}+1)A_2 + (2+\sqrt{3})B_2 = 0,$$

$$(\sqrt{3}-1)A_3 - (2-\sqrt{3})B_3 = 0,$$

which are the same as those given by (6) although T_1 is of the type (a).

$$(iii) \quad (D^2-17)x - (5D-3)y = (t+t^2)e^{-t}, \\ \& \quad (D+5)x + (D-1)y = 0.$$

This is of type (b).

$$F(D) = (D+1)^2(D+2),$$

$$X = (A_1 + A_2 t)e^{-t} + A_3 e^{-2t}, \quad Y = (B_1 + B_2 t)e^{-t} + B_3 e^{-2t},$$

$$P = e^{-t} \left(-\frac{3}{2}t^2 + \frac{2}{3}t^3 - \frac{1}{6}t^4 \right) \quad \text{and } Q = -e^{-t} \left(\frac{3}{2}t^2 - \frac{1}{3}t^3 + \frac{1}{3}t^4 \right)$$

On substituting $x = X + P$ and $y = Y + Q$, we get

$$2B_1 = 4A_1 + 3A_2 - 3, \quad B_2 = 2A_2 - 3 \quad \text{and } B_3 = A_3.$$

Here again, the equations are not all homogeneous; (cf. Ex. 1 on p. 346 of ref. [1]).

REFERENCES

- [1] A. R. Forsyth, *Treatise on Differential Equations*, 6th ed., pp. 342-350.
[2] G. Chrystal, *Trans. Roy. Soc. Edin.*, vol. XXXVIII, (1897), pp. 163-178.

DISSOCIATION ENERGY OF C_2

BY N. R. TAWDE

A GOOD deal of controversy seems to raise over the question of the dissociation energy of C_2 . Herzberg's¹ estimate of 3.6 e.v. is considered to be rather very low by Gaydon² who, from graphical extrapolations of different methods, arrives at a value for $D(C_2)$ round about 5 e.v. and contends that in any case, the value of dissociation energy is not likely to be less than 4 e.v.

It is found possible and interesting to bring the quantitative vibrational intensity distribution on C_2 (Swan) bands involving the ground state $3\pi_u$ and the upper state $3\pi_g$ to bear on this problem. The statistical weights in a state are a function of vibrational energy according to the equation

$$p_{v'} = C \cdot P_e \cdot \exp. (- E_{v'}/kT)$$

where $p_{v'}$ represents the statistical weight of the vibrational level v' having vib. energy $E_{v'}$,

P_e , the total statistical weights in the upper electronic state and is taken as the sum $(p_0 + p_1 + p_2 + \dots)$ for $v' = 0, 1, 2, \dots$ etc.

and C is a constant.

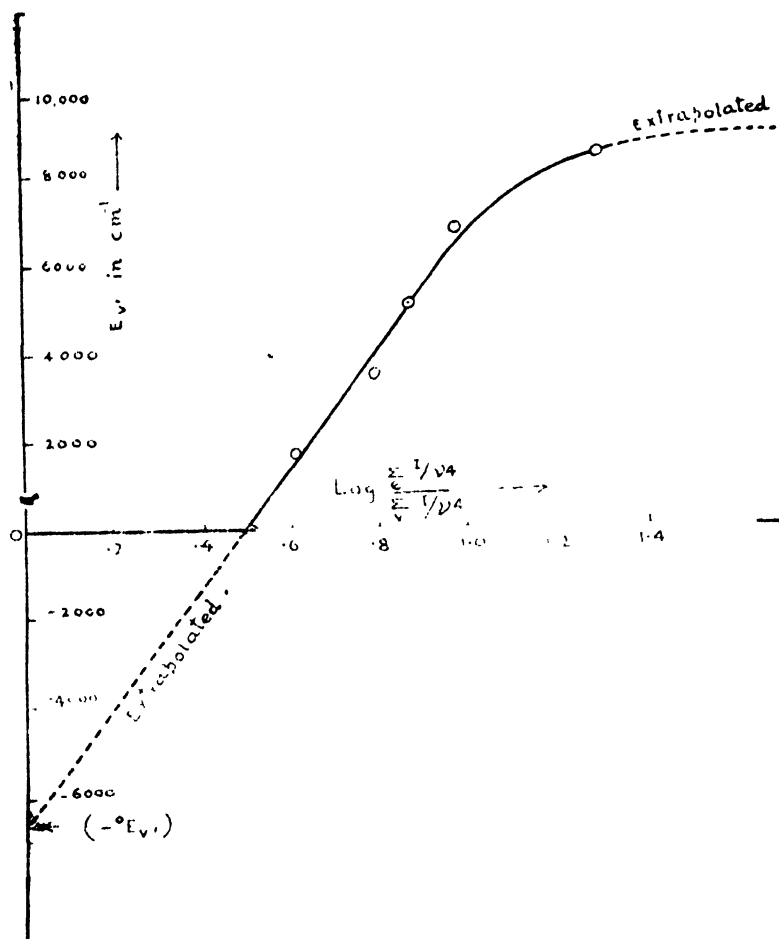
We can take $P_e \propto \sum_c I/v^4$ and $p_{v'} \propto \sum_{v'} I/v^4$, the populations and show from the above relation that

$$\text{Log } \frac{\sum_c I/v^4}{\sum_{v'} I/v^4} \propto E_{v'}/kT$$

The quantity on the left hand side is computable from the observed relative intensity values I , and kT being a constant for a given excitation condition, we can represent this relation graphically by plotting

$\text{Log } \frac{\sum_c I/v^4}{\sum_{v'} I/v^4}$ against the known energy values $E_{v'}$. The following is a

typical graph from the results of one of the investigations of Tawde and collaborators.³



It will be seen that the relation is a straight line in the region of lower levels and shows a tendency to flatten out at higher vibrational levels due to rapid fall in populations, indicating closely approaching limit of dissociation.

The ratio $\text{Log } \frac{\sum I/v^4}{\sum I/v^4}$ is greater than unity at $v' = 0$ and

increases for higher values of v' . The graph being a straight line in the lower v' regions, it is possible to extrapolate it to the value

$\text{Log } \frac{\sum I/v^4}{\sum I/v^4} = 0$, or $\frac{\sum I/v^4}{\sum I/v^4}$ equal to unity, and determine the corresponding point on the vibrational energy co-ordinate.

This comes out in the negative region and may be considered as critical point or level in the upper electronic state at which all the populations are expected to be steady before they distribute in the higher vibrational levels of that state. If we imagine this to be the starting point for the measure of vibrational energy or 'absolute zero' of it, the total energy measured upto the last observed vibrational level v' (i. e. 5 for Swan bands of C_2) gives an estimate of the dissociation energy of C_2 . We may denote this 'absolute zero' by $(-^{\circ}E_v)$. Curiously enough for results of ten independent experiments of Tawde and collaborators,^{3,4} the extrapolated point

($-\circ E_v$)—locates to nearly the same value correct to about $\pm 700 \text{ cm.}^{-1}$ or approximately 0.09 e. v. The dissociation energy values of the ten experiments, computed as above, are recorded in the following tables :

<i>Source of excitation</i>	<i>Estimate of $D(C_2)$ in e.v.</i>
A. Oxy-coalgas flames :	
i. Fuel-oxygen ratio 1.25	4.25
ii. „ „ „ 2.0	4.15
iii. „ „ „ 3.0	4.25
iv. „ „ „ 4.0	4.25
v. „ „ „ 5.0	4.15
B. Discharge in argon :	
i. Pressure 10 mm.	4.25
ii. „ 15 „	4.25
iii. „ 20 „	4.25
iv. „ 25 „	4.20
v. „ 30 „	4.25

The mean of the above values works out as 4.22 ± 0.01 e. v., which with the uncertainty indicated above in the location of extrapolated point $\circ E_v$, gives the result for $D(C_2)$ as approximately 4.2 ± 0.1 e.v. Since this is worked upto the limit where flatness of graph begins to set in, the estimate made is the lower limit of dissociation energy. Excitation condition thus influences the result only to the extent of not more than 0.1 e. v. Examining the upper limit, the graph gets flattened by extrapolation after a further rise of about 800 to 900 cm.^{-1} , so that the higher limit of dissociation energy can be safely set at 4.3 ± 0.1 e. v. Hence the above method based upon the extrapolation of intensity distribution gives an estimate of $D(C_2)$ that strengthens considerably the argument of Gaydon that the dissociation energy of C_2 is not likely to be lower than 4 e. v. Some other molecules are being examined in the same way.

REFERENCES

1. Herzberg; *Astrophys. J.*, 1939, *89*, 290; 'Molecular Spectra and Molecular Structure', New York, 1939, pp. 472.
2. Gaydon; 'Dissociation Energies', 1947, pp. 189-190.
3. Tawde and Patel; *Bom. Univ. J.*, 1937, *6*, 29.
4. Tawde and Desai; *Proc. Ind. Acad. Sc.*, 1937, *6*, 266.

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STUDY OF THE EXCITATION OF A BAND SYSTEM FROM A METAL AND ITS OXIDE

BY N. R. TAWDE AND A. G. HUSAIN

INTRODUCTION

MUCH work has been done on the study of the change in gross intensity distribution in a band system with the variation in the conditions of excitation. However, from the investigations of Lochte-Holtgreven¹ we were led to think that the gross intensity distribution in a band system should depend not only upon the conditions of excitation but also upon the chemical form, and composition of the substance used. Lochte-Holtgreven¹ in his investigations employed acetylene and ethylene, each of which when separately excited in a discharge tube, yielded simultaneously the C₂ and CH bands. According to his results, the effective "rotational" temperatures for the simultaneously excited C₂ and CH bands arising from acetylene were found to differ from those given by these systems arising from ethylene.

A problem of this type of exciting simultaneously two band systems in the same source has been tackled previously by Tawde and Trivedi from the standpoint of vibrational energy. A natural corollary of this, as pointed out above, is the excitation of a given band system from two substances (of different chemical composition) in exactly similar sources under uniform conditions. As for instance, we have the bands of AlO system due to transition $B\ ^2\Sigma \rightarrow X\ ^2\Sigma$ which would be obtained in a carbon arc by feeding it by (i) metallic aluminium and (ii) aluminium oxide successively. Similar is the case with BeO bands ($^1\Sigma \rightarrow ^1\Sigma$) which excite in a carbon arc fed with metallic beryllium as well as beryllium oxide, BeO. It is these aspects that have been dealt with in this investigation which aims at measuring the intensity distribution and finding out its dependence, if any, on the nature and composition of the substances used, under similar conditions of excitation. As in Tawde and Trivedi's² work on CN and AlO bands, the problem here ultimately concerns the computation of "effective vibrational temperatures" from the measure of gross intensity distribution in the bands of AlO and BeO systems excited as mentioned above.

Such a problem is thought to give an insight into the processes occurring in a substance, prior to its conversion to a physically stable radical. In an advance note published by Tawde and Husain,³ a brief reference is made to the results and conclusions on these aspects. Secondly, the 'effective temperatures' derived from the experiments could be used to obtain further evidence for the temperature gradient within the carbon arc, as suggested already by Tawde and Trivedi.² Further, these considerations have a bearing on the hypothesis of "optimum temperatures" of molecules in relation to temperatures of sources, put forth by Coheur and Coheur⁴ and discussed by Tawde⁵ in a previous note

on the subject. The choice of carbon arc as the excitation source was guided by the fact that in it, the Maxwell-Boltzman distribution is supposed to hold and as such the derived effective temperatures either rotational or vibrational are expected to agree closely with the true temperatures in carbon arc. This view has already enough support from a number of observations on record and will be further examined in the light of data proposed to be obtained in these experiments.

EXPERIMENTAL

The technique of intensity measurements is the same as that employed by Johnson & Tawde⁶ and Tawde and Collaborators.^{7,8} Throughout the work the atmospheric carbon arc was operated from 230 volts d.c. mains at a constant current of 4 amps. and the arc space was adjusted to remain fairly constant at 0.8 cm. For the excitation of the BeO system from the metal as well as from its oxide, granular beryllium metal and beryllium oxide (anhydrous) of Schering Kahlbaum were used. For AlO system, aluminium metal filings and Merck's aluminium oxide (Al_2O_3 anhydrous) were used. For photographing the bands of both the BeO and AlO systems, a Hilger constant deviation instrument was most suitably employed. The plates used for the purpose were the Ilford Rapid Process Panchromatic. Adjacent to the spectrum strip, blackening marks were impressed on the plate by means of a step-slit illuminated by a standard lamp of known energy distribution. This lamp was calibrated by Dr. R. C. Johnson and Dr. N. R. Tawde at the Government Chemical Laboratories, London. The plates were microphotometered on a Zeiss self-recording instrument and the peak values of the intensities immediately near the band head were computed and expressed in terms of the energy of the standard lamp read from its $E_\lambda - \lambda$ curve.

RESULTS

The results of intensity measurements in the BeO system are recorded in the following table I. Column 1 gives the bands designated by their vibrational quantum numbers. Column 2 gives the intensity values I_M side by side with I_M/ν^4 values for bands excited from the metal while column 3 gives the same for its oxide as denoted by I_0 & I_0/ν^4 . All the relative intensities are expressed on the basis of the (0, 0) band as 100. In column 4, the selective enhancement for one substance with respect to the other is expressed by the ratio of I_0/I_M for each band of the system.

TABLE I. BeO System

Band	Beryllium		Beryllium Oxide		Ratio
	I_M	I_M/ν^4	I_0	I_0/ν^4	I_0/I_M
(1,0)	12.1	4.64	11.1	4.26	0.92
(2,1)	11.6	4.58	11.2	4.42	0.96
(3,2)	9.82	3.94	7.56	3.03	0.77
(4,3)	7.42	3.04	....	....	....
(5,4)	6.55	2.73	2.81	1.17	0.43
(6,5)	3.37	1.43	1.84	0.78	0.55

TABLE I—(continued)

Band	Beryllium		Beryllium Oxide		Ratio
	I_M	I_M/γ^4	I_O	I_O/γ^4	I_O/I_M
(0,0)	100	49.21	100	49.21	1.00
(1,1)	56.3	28.30	52.8	26.52	0.94
(2,2)	40.2	20.55	23.2	11.88	0.58
(3,3)	16.7	8.69	12.8	6.68	0.77
(4,4)	9.06	4.80	9.33	4.94	1.03
(5,5)	7.50	4.03	8.63	4.64	1.15
(0,1)	40.1	26.21	47.3	30.88	1.18
(1,2)	46.1	30.62	42.9	28.48	0.93
(2,3)	36.5	24.60	33.4	22.53	0.92
(3,4)	26.7	18.24	18.4	12.57	0.69
(4,5)	21.6	14.93	14.0	9.69	0.65
(5,6)	15.2	10.63	9.45	6.61	0.62
(0,2)	4.87	4.29	4.29	3.78	0.88
(1,3)	7.06	6.29	7.27	6.48	1.03
(2,4)	6.81	6.14	7.91	7.13	1.16
(3,5)	4.36	3.96	2.64	2.40	0.61

Similar results of AlO system have been entered in Table II below.

TABLE II. AlO System

Band	Aluminium		Aluminium Oxide		Ratio
	I_M	I_M/γ^4	I_O	I_O/γ^4	I_O/I_M
(2,0)	9.24	3.70	.....	.....	.....
(3,1)	22.8	9.32	17.8	7.27	0.78
(4,2)	14.4	6.08	16.1	6.81	1.12
(5,3)	9.55	4.06	11.4	4.83	1.19
(6,4)	6.88	2.95	9.08	3.92	1.33
(7,5)	6.33	2.79	7.30	3.21	1.15
(8,6)	5.17	2.30	5.78	2.58	1.12
(9,7)	4.87	2.18	4.94	2.20	1.01
(1,0)	45.0	21.10	37.3	17.52	0.83
(2,1)	46.2	22.08	16.8	7.95	0.36
(3,2)	27.9	13.60	11.7	5.71	0.42
(4,3)	22.2	11.01	6.75	3.30	0.30
(5,4)	12.5	6.30	6.17	3.09	0.49
(6,5)	5.16	2.65	1.53	0.80	0.30
(0,0)	100	55.15	100	55.15	1.00
(1,1)	37.4	21.04	23.7	13.25	0.63
(2,2)	7.64	4.38	6.09	3.50	0.80
(0,1)	47.7	31.88	43.7	29.33	0.92
(1,2)	47.9	32.55	32.0	21.15	0.65
(2,3)	31.1	21.51	26.6	18.49	0.86
(3,4)	23.1	16.21	25.8	18.16	1.12
(4,5)	13.8	9.80	24.0	17.05	1.74
(5,6)	6.04	4.35	13.8	9.92	2.28
(6,7)	5.56	4.06	6.13	4.47	1.10

TABLE II—(continued)

Band	Aluminium		Aluminium Oxide		Ratio
	I_M	I_M/ν^4	I_O	I_O/ν^4	I_O/I_M
(0,2)	15.0	12.19	25.3	20.60	1.69
(1,3)	20.8	17.18	16.3	13.57	0.79
(2,4)	14.5	12.12	10.1	8.48	0.70
(3,5)	7.93	6.74	3.76	3.17	0.47
(4,6)	6.50	5.59	3.29	2.85	0.51

Excitation function for each of the upper vibrational level ν' has been calculated from the above tables by summing up the I/ν^4 values of each band in a ν'' -progression. This is expressed as $\sum_{\nu'} I/\nu^4$ and entered in the following Table III (BeO system) and Table IV (AlO system). Columns 2 and 3 therein give these values for bands resulting from the metal and its oxide respectively.

TABLE III. BeO System

 $\sum_{\nu'} I/\nu^4$ Values

Progression	Beryllium	Beryllium Oxide
$\nu' = 0$	79.71	83.87
1	69.85	65.74
2	55.87	45.96
3	34.83	24.68
4	22.77	14.63
5	17.39	12.42
6	10.80	00.78
Total	291.22	248.08

TABLE IV. AlO System

 $\sum_{\nu'} I/\nu^4$ Values

Progression	Aluminium	Aluminium Oxide
$\nu' = 0$	99.22	105.08
1	91.87	65.49
2	63.79	38.42
3	45.87	34.31
4	32.48	30.01
5	14.71	17.84
6	9.68	9.19
7	2.79	3.21
8	2.30	2.58
9	2.18	2.20
Total	364.87	308.33

EFFECTIVE TEMPERATURES

The values $\sum_v I/v^4$ of Tables III and IV enable us to compute the effective vibrational temperatures. These have been obtained for both the cases (metal and its oxide) in BeO and AlO systems. The equations used for the vibrational energy in the upper state have been worked out from the data recorded by Jevons. They are as follows :—

$$\text{BeO } ({}^1\Sigma \rightarrow {}^1\Sigma): 1370 \cdot 81 (v' + \frac{1}{2}) - 7 \cdot 76 (v' + \frac{1}{2})^2 = 1 \cdot 6083 T \text{ Log}_{10} \frac{N_0}{N_{v'}}$$

$$\text{AlO } ({}^2\Sigma \rightarrow {}^2\Sigma): 868 \cdot 15 (v' + \frac{1}{2}) - 3 \cdot 75 (v' + \frac{1}{2})^2 = 1 \cdot 6083 T \text{ Log}_{10} \frac{O_0}{N_{v'}}$$

Where N_0 is the number of molecules in the $v'=0$ state. Taking the values of $N_{v'}$, of any v' —state proportional to $\sum_v I/v^4$ values

(Tables III & IV), it is possible to calculate the factor $\text{Log}_{10} \left(\frac{N_0}{N_{v'}} \right)$

i.e. $\text{Log}_{10} \left(\frac{\sum_0 I/v^4}{\sum_{v'} I/v^4} \right)$ for any v' —level. The corresponding vibrational energy of the levels is determined by the left hand side of the

equation and plotted against $\text{Log}_{10} \left(\frac{\sum_0 I/v^4}{\sum_{v'} I/v^4} \right)$. These graphs give

nearly a straight line relatively in each case, the slope $1 \cdot 6083T$ of which enables effective temperature T° (Abs) being determined. These have been entered in the following table V and have been designated as T_M for metal and T_O for its oxide. The ratio T_M/T_O has been given side by side.

TABLE V. Effective temperatures

System	Temps.		Ratio T_M/T_O
	T_M	T_O	
BeO	4590°K	3330°K	1.38
AlO	3525°K	2570°K	1.37

DISCUSSION AND CONCLUSIONS

The chief points for consideration in connection with the present work are :—

(a) The evidence pointing to the confirmation of previous conclusions as regards the temperature equilibrium of vibrational energy within the carbon arc.

(b) The temperature distribution within the arc, if any.

(c) The dependence of effective vibrational temperature, if any, on the nature and the composition of the substance used and on the particular molecular radicals BeO and AlO.

These have been examined below one by one.

The available data on temperatures derived from band spectra show that only in certain sources, temperature equilibrium of vibrational energy exists. Johnson and Tawde⁶ and Tawde⁹ have used various methods of excitation for obtaining effective vibrational temperatures from intensity distribution in certain band systems. In none of these except the carbon arc, have they found computed temperatures to approximate to true temperatures. The following results gathered (Table VI) from various authors show the order of temperatures that one expects in carbon arc. The methods by which they are arrived at are classified under 4 different heads, (1) spectroscopic, (2) electron density, (3) sound wave photographs, and (4) miscellaneous.

TABLE VI

DATA ON TEMPERATURES OF CARBON ARC

(a) *Spectroscopic.*

Condition of source, method, etc.	Temperature in °K
Line intensities (Ornstein and Sambursky) ..	6000°
Line intensities (Hydrogen at Atmospheric pressure) ..	4900°-6300°
Swan bands : 10 Amp. Arc in air ..	6000°
Swan bands : (Johnson) ..	6000°
Swan bands : (Johnson and Tawde) ..	5000°
Swan bands : (Krygsmann) ..	6000°-6500°
CN bands : 9 Amp. arc in air ..	5000°
CN bands : 7 Amp. arc in air ..	6550°
CN bands : 1-12 Amp. arc in air ..	6500°
CN bands : (Tawde) ..	7000°

(b) *Electron Density.*

3 Amp. arc in air ..	5000° ± 400°
3 Amp. arc in air ..	5200° ± 450°
Along arc axis (Hörman) ..	6000°-7000°

(c) *Sound wave photographs.*

Condition of source, method, etc.	Temperature in °K
50 Amp. cored carbon arc in air ..	$5500^{\circ} \pm 150^{\circ}$
6 Amp. arc in air (long column) ..	$4050^{\circ} \pm 200^{\circ}$
25 Amp. tungsten Arc in air ..	$6440^{\circ} \pm 150^{\circ}$
125 Amp. welding arc in air ..	6020°
43 Amp. cored carbon ..	4740°

(d) *Miscellaneous.*

(i) Ionisation (Mankopff) ..	$6000^{\circ} - 8000^{\circ}$
(ii) 10 Amp. arc at 1000 atmospheres by the method of arc gradient and current density ..	$10,200^{\circ}$

The temperatures obtained in the present investigations by exciting the various substances in the carbon arc under similar conditions at a current of 4 Amp. and under atmospheric pressure are already stated in Table V. They are not very far from the previously determined values of Johnson & Dunstan¹⁰ for BeO and of Tawde and Trivedi⁸ for AlO.

From the above table VI, it is easy to gauge the limits within which the temperatures of carbon arc lie. These appear to be characterised by current in the arc to a slight extent, but by pressure to an appreciable extent, as can be seen from the conditions stated in the left column of the table VI. For instance, a 10-amp. arc at 1000 atmospheres gives the temperature in the neighbourhood of $10,000^{\circ}\text{K}$ as seen under d (ii) of the table VI above. For majority of cases, i. e. atmospheric arc, with a fairly wide variation in current, the temperature broadly ranges round about the average 5000°K , which is ordinarily supposed to approximate to true temperature of the arc, observed perpendicular to its axis. Comparison with the values of these experiments recorded in table V indicates the existence of temperature equilibrium within the atmospheric arc. Evidence of such an equilibrium follows particularly from the agreement in temperature results from sound velocity measurements, ionisation data and band spectrum methods. The agreement is suggestive of thermal equilibrium in arc, of vibrational or rotational energy. Our results are not inconsistent with the available data. This is unlike the flame sources where according to investigations of Johnson and Tawde⁶ and Tawde and Patel⁸, C. (Swan) bands give imaginary temperatures quite different from the true temperatures expected in those flames. Thus the temperatures obtained by us in these experiments can be well justified as true equilibrium temperatures of carbon arc. More detailed supporting data on this aspect are supplied by Husain.¹¹

Any higher or lower temperatures recorded here are not to be ascribed to the absence of thermal equilibrium, but as an evidence of varying temperatures corresponding to different regions of the arc. This is confirmed in the present case where radiations giving undiluted band system concerned, were spotted at separate places within its field. That the colour of this radiation also varied slightly according to the substance fed into the arc, was verified by noting the same visually every time and the rough location of it in the arc zones. The following detailed notes were made on these points and the corresponding computed temperatures given side by side.

TABLE VII

Substance	Colour of the stream radiation in the arc	Broad region of the arc	Temperature
Be (metal)	Bluish	A little outside arc axis	4590°K
Al (metal)	Bluish green	Somewhat further from axis	3525°K
Be (oxide)	Yellowish green	Further from the axis	3330°K
Al (oxide)	Yellowish tinge	Outer flame portion of arc	2570°K

It is known that when an arc is struck in air, very intense violet glow is seen almost in the centre of the arc space. This is a portion recognized to give CN violet band system. An average high order temperature of about 6500°K has been assigned to this, according to several observers. Against this there is also the lower temperature having mean value of $3820 \pm 15^\circ\text{K}$. (International Temperature scale) in the positive crater of the standard pyrometric carbon arc described by McPherson.¹² The higher and lower limits of temperature recorded above are therefore not unexpected and can be further explained on the basis of temperature gradient for which a case is made out below. When the lower carbon electrode is packed with Be-metal, and the arc struck, the violet CN bands were seen in the background along with the BeO bands when approximately central portion was focussed on the slit, but when a slight displacement of the arc portion was caused, the spectrum became clear of CN-violet system and gave undiluted BeO bands. Owing to natural fluctuations in the arc discharge, however, CN bands sometimes came into the field. The arc was consequently adjusted while looking into the spectrum and it was identified that the portion which corresponded to bluish colour gave distinct BeO system

without background of any other banded radiation. Adjustments were carried out and observations made in a similar way when dealing with other substances fed into the arc. Table VII above, as mentioned already, is a consequence of the observations recorded in this way.

The fact is thus established that the intended spectral region (BeO or AlO) in the arc varied every time the substance fed into the arc was changed and it was found that this gave different values of temperature. Starting thus from the central violet CN-glow in the central or axial core of the arc and passing out radially, we obtain temperature values diminishing unmistakably by appreciable amounts in the order CN, Be, Al, BeO and Al_2O_3 .

The above findings may be adduced as an evidence in favour of temperature gradient within the arc in the manner shown below diagrammatically (Fig. 1).

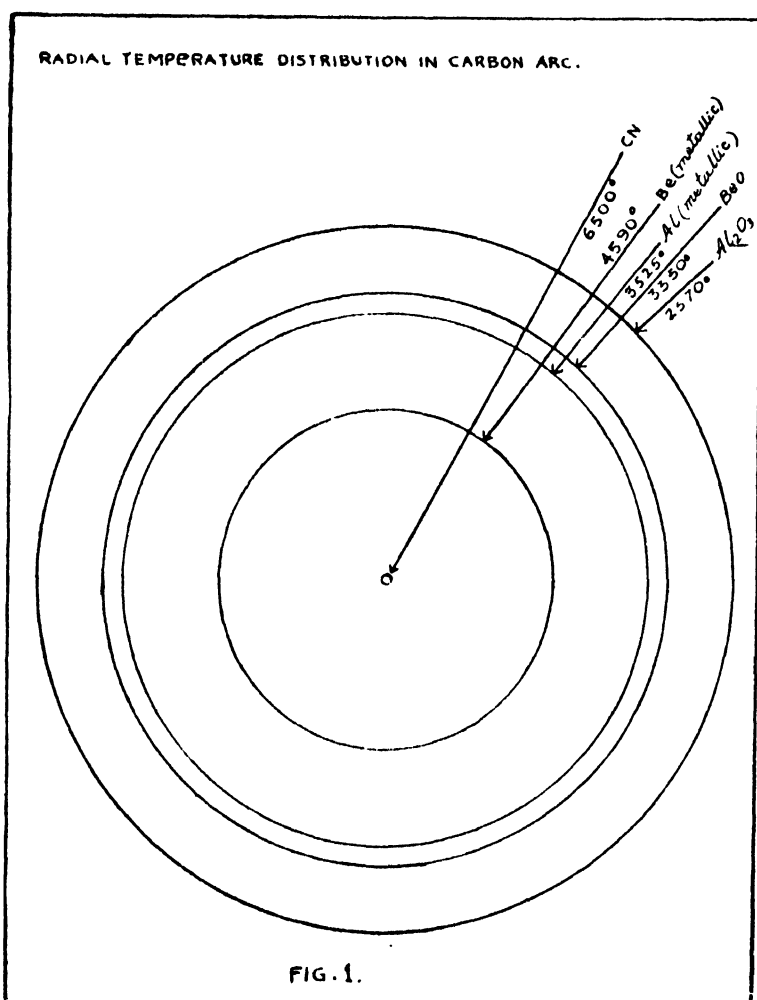


FIG. 1.

These conclusions are unlike the view of Coheur and Coheur[†] that the temperature is not the characteristic property of the source of excitation, nor is there the existence of temperature gradient in the arc.

Looking to the temperature values derived from BeO system, one finds that they differ by about a 1000°K , when Be-metal is replaced by beryllium oxide. Similarly the difference is of the order of 800°K for AlO system when metallic aluminium is replaced by aluminium oxide Al_2O_3 . This, under constant conditions of the arc, is a relatively large difference to be neglected and hence two different temperatures are attributable to the same system in the same source. This result is contrary to the conclusions of Coheur and Coheur,[†] who find the same temperature for AlO system from rotational energy, irrespective of the chemical composition of the substance used or of the source of excitation. Even though the temperatures of Coheur & Coheur are rotational temperatures, they can be considered in relation to our results in view of the case made out above for thermal equilibrium of both vibrational and rotational energy in the carbon arc source. It is therefore extremely doubtful that as suggested by Coheur & Coheur, the temperature has an optimum value or is a specific property for a particular molecule.

The reasons for the difference in temperature for the same molecular radical may therefore be sought in the nature and composition of the substance used, viz., metal or its oxides. These are likely to undergo changes as a results of equivalent thermal energy supplied by the arc. In the case of metallic substances, we may assume the total energy required upto the final stage of excitation to be the sum of energies to melt the substance, vapourise it, oxidise the same and excite the resulting radicals BeO or AlO. In the case of oxides, the processes will be the same except for oxidation. If these energies are found out to be different, then the difference in temperature can possibly be explained to a certain extent. But in the absence of the full data of thermal and other constants, it is not possible to form a relative estimate of the energies required for metal and its oxide.

It is, however, significant to note that the ratios of the effective temperatures $T_{\text{M}}/T_{\text{O}}$ in both the band systems BeO as well as AlO come to be nearly the same (Table No. V).

SUMMARY

Quantitative intensity measurements along the vibrational levels have been carried out in case of the BeO ($^1\Sigma \rightarrow ^1\Sigma$) and the AlO ($^2\Sigma \rightarrow ^2\Sigma$) systems, excited in the carbon arc when fed respectively by the metallic and oxide substances, under analogous conditions of excitation. From the results of intensity measurements, the effective vibration temperatures are derived for all the four cases viz. Be, BeO, Al and Al_2O_3 . The results of intensities and the effective temperatures have been utilized to interpret three aspects—(1) The temperature equilibrium of vibrational energy in arc excitation; (2) The temperature distribution within the arc; (3) The dependence of effective temperature on the chemical composition of the substances giving a particular band system.

REFERENCES

- (1) Lochte-Holtgreven, Zeit. f. Phys. 1930, 64, 443 ; 1931, 67, 590.
- (2) Tawde and Trivedi, Proc. Phys. Soc. 1939, 51, 733 ; 1937, 140, 463.
- (3) Tawde and Husain, Science and Culture, 1945, 10, 509.
- (4) Coheur and Coheur, Phys. Rev. 1946, 69, 240.
- (5) Tawde, Phys. Rev. 1946, 70, 432.
- (6) Johnson and Tawde, Proc. Roy. Soc. 1932, 137, 575.
- (7) Tawde, Proc. Phys. Soc. 1934, 46, 324.
- (8) Tawde and Patel, Bcm. Uni. Jour. 1937, 6, 29.
- (9) Tawde, Proc. Ind. Acad. Sc. 1936, 3, 140.
- (10) Johnson and Dunstan, Phil. Mag. 1933, 16, 472.
- (11) Husain, M Sc. Thesis, 1942, Bombay University.
- (12) McPherson, "Temperature, its Measurement and Control in Science and Industry" published by the American Institute of Physics, 1941, p. 1146.

SPECTROSCOPIC LABORATORIES,
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SOME SPECTRAL CHARACTERISTICS OF THE POSITIVE COLUMN OF A SODIUM VAPOUR LAMP

By N. R. TAWDE AND G. K. MEHTA

INTRODUCTION

RECENTLY Tawde, Patil and Mehta¹ reported some unusual splitting phenomena associated with the characteristic sodium D lines emitted by a Philips 'Philora' sodium vapour lamp. On the basis of the measured separation of the components of the two lines λ 5890 and λ 5896, which they obtained by photographing the Lummer plate pattern, they suggested some predisposing causes of the observed splitting. Though they could not with certainty account for the effect, among the possibilities indicated by them, stress was laid on Stark effect, combined with self-reversal.

Further work on the subject was pursued in this laboratory with a view to trace the probable causes of the so-called splitting or broadening produced. In the course of the work, the senior of the present authors received a confirmation of the observed broadening in a private communication (May 1946) from Dr. Le Roy Apker of the General Electric Co., Schenectady, U. S. A. He along with late Dr. J. S. Campbell of the University of Rochester had noticed the phenomena earlier, but had not published the results of his measurements. Curiously enough it happens that the results now reported to us by Dr. Apker are in very close agreement with ours. The separation in 5890 line is exactly the same while that of 5896 line agrees within 99%. No doubt this close coincidence is expected to be due to accidental similarity of the excitation conditions.

EXPERIMENTAL AND RESULTS

Before describing the experimental work it is necessary to give a brief description of the lamp used, for the sake of proper understanding.

Description of the Lamp

The Lamp used was Philips 'Philora' 85 watt sodium vapour lamp (same as used by Tawde, Patil and Mehta). This lamp is of the positive column type and consists of a long narrow tube of glass (sodium resistant) bent in the form of a U-tube, the length of each limb being 20 cm. The ends of the tube carry two oxide-coated electrodes. These electrodes are heated by the discharge current. This lamp element is surrounded by a double walled glass vacuum jacket which protects it against the influence of the ambient temperature and makes the sodium vapourise quickly without undue loss of heat. The lamp is operated at 6 amps. from 230 volts A. C. in conjunction with the electrical gear (leak transformer) and has a voltage drop of 140 volts across it. The lamp contains neon at a pressure of a few mm. and a small amount of sodium.

When the lamp is switched on at room temperature the sodium is in the solid state and does not contribute to the discharge which then takes place entirely in neon showing the characteristic orange red colour. The energy from the neon discharge raises the temperature of the tube and sodium begins vapourising. It takes about ten minutes for the lamp to warm up and attain full brightness, when the radiation due to neon is completely swamped and practically the whole of the luminous output of the lamp consists of the characteristic yellow colour of the D doublet of sodium. Observing the appearance of the interference patterns of the doublet with a Lummer plate in conjunction with a constant deviation spectrometer, we see the following phenomenon: (from the time the sodium begins vapourising till the lamp attains its full efficiency). In the beginning we observe each of the two lines giving their normal monochromatic interference pattern, but as the lamp gets heated up, each of the fringes in the two wave lengths begins to broaden out and ultimately develops almost symmetrical splitting into two defined components. Photographs Fig. 1 (a) & (b) show the interference patterns in the stabilizing and stabilized condition of the lamp. These are each accompanied by their microphotometer records.

For the purpose of getting some evidence about the probable cause of the phenomena it was decided to examine the separation of the components for both the lines at different regions along the discharge column where the conditions differ. For this purpose the photographs of the interference patterns were taken at the following three regions along one of the limbs of the lamp in its final stabilized condition: (i) Just near the electrodes; (ii) At the middle portion of the limb; (iii) At the top of the limb *i.e.* midway between the electrodes. Symmetrical conditions are expected to prevail for the other limb of the discharge.

The calculated separations from the observations are recorded in the following table I.

TABLE I

Separation of $D_1 D_2$ lines.

(Lamp fully bright—with vacuum jacket on)

Region	Separation in A. U. for 5890	Separation in A. U. for 5896	Neon Spectrum
(i) Near the electrode	Intensity very weak, slight trace of broadening	Intensity very weak, slight trace of broadening	Rich in intensity
(ii) At the middle portion of the limb	0.077 ₂	0.059 ₆	Suppressed

TABLE I—(continued)

Region	Separation in A. U. for 5890	Separation in A. U. for 5896	Neon Spectrum
(iii) At the top of the limb	0.065 ₄	0.056 ₀	Suppressed
Previous results of Tawde, Mehta & Patil	0.064	0.053	Ditto.

These observations were repeated with the vacuum jacket removed from the discharge lamp. In this case it was noticed that the sodium doublet was very weak in intensity and the neon spectrum was quite easily noticeable even after the lamp was allowed to run for a considerable time for initial heating. Table II below gives the record of observations.

TABLE II

(Lamp with vacuum jacket removed)

Region	Character of sodium D lines	Neon lines	Remarks
(a) At electrode	Feeble (1)	Strong (10)	Sodium lines masked by neon
(b) Middle por- tion of the limb	Strengthening (9) Slight broad- ening	Weakening (3)	Sodium lines get clear of neon
(c) Top of the limb	Strong (10) show- ing considerable broadening	Feeble (2)	Sodium yel- low doublet clear

Note :—The figures in bracket indicate the relative intensities judged visually.

The spectrum was also photographed in the pre-stabilised state with the vacuum jacket on, about 7 min. after the switching on. The characteristics were closely the same as shown in Table II,

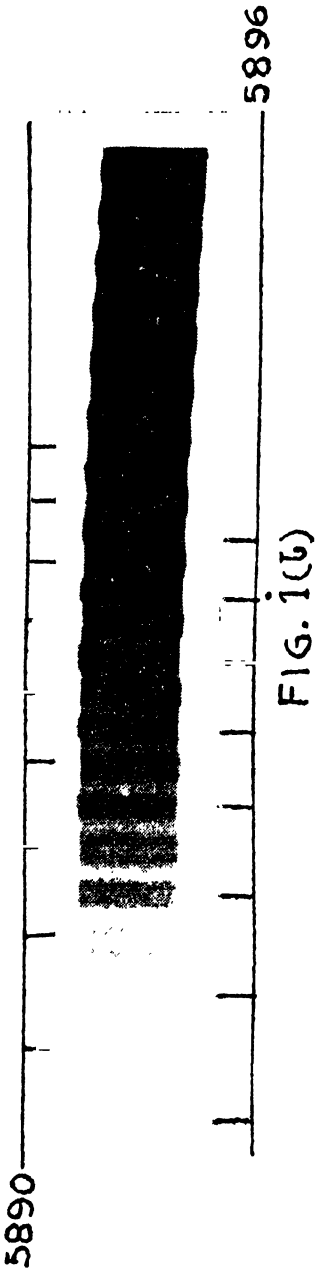
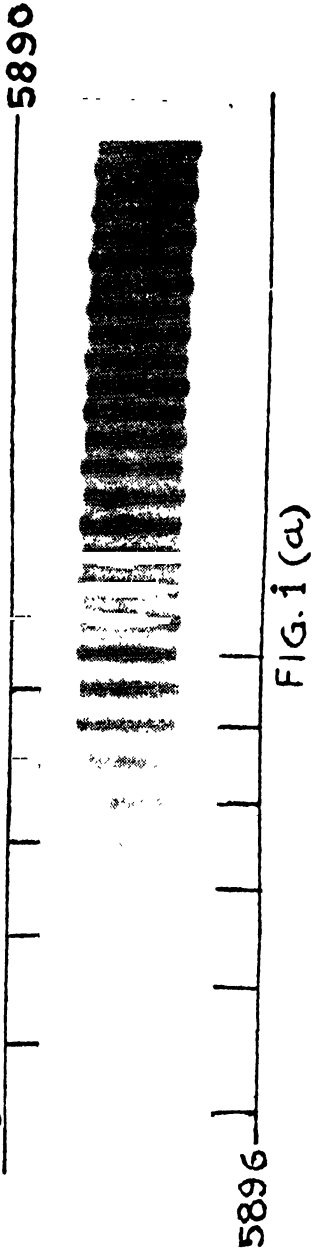
DISCUSSION

Before we pass on to consider the results, it is necessary to discuss the mechanism of excitation in the lamp. The lamp contains neon at a pressure of about 2 mm. and as the discharge passes, the temperature of the element is raised to about 230°C at which the vapour pressure of sodium is 0.2μ . Fonda and Young² have shown that for sodium vapour at this temperature of 230°C , the light output is maximum. Thus when the lamp is operating at full brightness the vapour pressure of sodium is about $\frac{1}{10000}$ th that of neon. There are thus two distinct stages of excita-

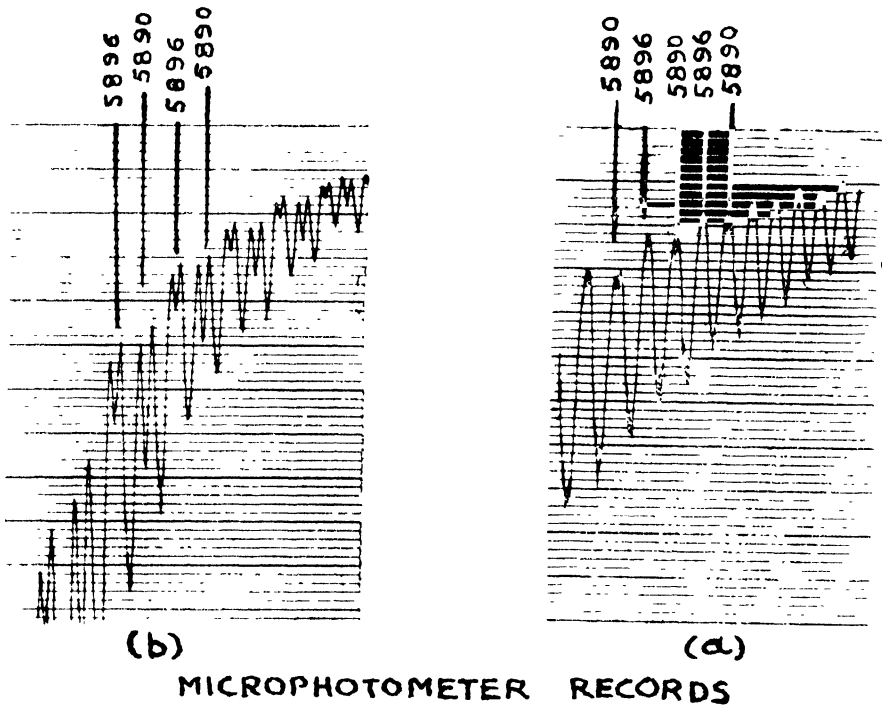
tion of the lamp—one the pre-stabilized stage when the radiation is all from neon with a trace of sodium D lines, and the other is the post-stabilized stage when the neon spectrum disappears and only the yellow doublet of sodium predominates. It is in this latter stage that the phenomena of the so-called splitting of the D lines becomes distinctly marked. The rôle of neon and the mechanism of excitation is described below.

The neon is not only for the initiation of the discharge but also plays an important part in the maintenance of the discharge. The ionisation of the sodium atoms will be very small and consequently the current flow will largely be due to the neon ions which are produced by collisions taking place in the region of the cathode fall. In spite of the very low partial concentration of the sodium atoms, the light output from the positive column consists mainly of the yellow radiation of the D doublet of sodium. This is because in the positive column the energy for the excitation and ionisation is acquired by the electrons from the relatively low potential gradient. The function of the neon atoms is to cause low energy (ultimate) electrons to travel a greatly increased distance (by having elastic collisions) before getting collected at the surface, so that they are very likely to make a collision with a sodium atom. The electrons have a mean energy corresponding to $40,000^{\circ}\text{K}$ and a considerable number of them have sufficient energy to excite sodium atoms (2.1 e. v.) Very few (about 1%) electrons will have energy equal to or greater than the lowest critical potential of neon (16.6 e.v.) and there is some excitation of neon. According to Compton & Langmuir³ a high concentration of meta stable atoms of neon along with the high random current density of the electrons, make cumulative ionisation of neon possible, which maintains the conductivity of the discharge. The ionisation of sodium at the low partial pressure does not contribute much to the conductivity. At the region near the electrodes where the potential drop is high, the electrons have sufficient energy to excite the neon atoms.

This accounts for the neon spectrum observed near the electrodes even when the lamp is in the fully stabilised state. (Table I). The appearance of the neon spectra in the absence of the vacuum jacket (Table II) can be explained on the grounds that the lamp does not attain the required temperature, i.e. 230°C and the sodium does not vapourise to give the required partial pressure. The strengthening of the sodium doublet in this case at the centre and top of the column shows that even at the very low partial pressure of sodium vapour, its excitation due to slow electrons is quite efficient in the positive column of the discharge.



[Fig. 1(a) & 1(b) continued]



(a) pre-stabilized, (b) post stabilized

The D_1 and D_2 lines of sodium are resonance lines. These lines are emitted when an excited sodium atom returns to the normal state, but the resulting radiation does not immediately pass out of the lamp. Due to the fact that it is resonance radiation it can be absorbed by the neighbouring unexcited atom causing excitation of the latter. Thus the light has to pass through the column by series of absorptions and re-radiations, before reaching the walls of the tube. Found⁴ has calculated, the absorption coefficient of sodium vapour for its own resonance radiation which is equal to 146. He finds that the m. f. path of the radiation, which he defines as the reciprocal of the absorption coefficient, is 0.007 cm. This means that 90% of the light from the lamp comes from a outer layer of sodium vapour, 0.015 cm. thick. Thus it appears that in this particular case the expected self-reversal of the lines due to absorption comes into effect. The actual opacity of the layers, that is the tendency for absorption, is expected to be maximum at the resonance wavelength (the centre of the resonance line) and then should fall at a rate propor-

tional to $\frac{1}{(\Delta\lambda)^2}$ where $\Delta\lambda$ is the wavelength distance from the resonance wavelength. In the beginning in the pre-stabilized stage at lower temperatures, the effect of the incipient self-absorption is to show greater half intensity width, as a result of the flattening of the intensity peak. As the density of the absorbing layer increases with the rise in temperature owing to much higher opacity at the core of the line, the central portion of the line is relatively more absorbed than the wings and the line takes the form as shown in Fig. (ii).

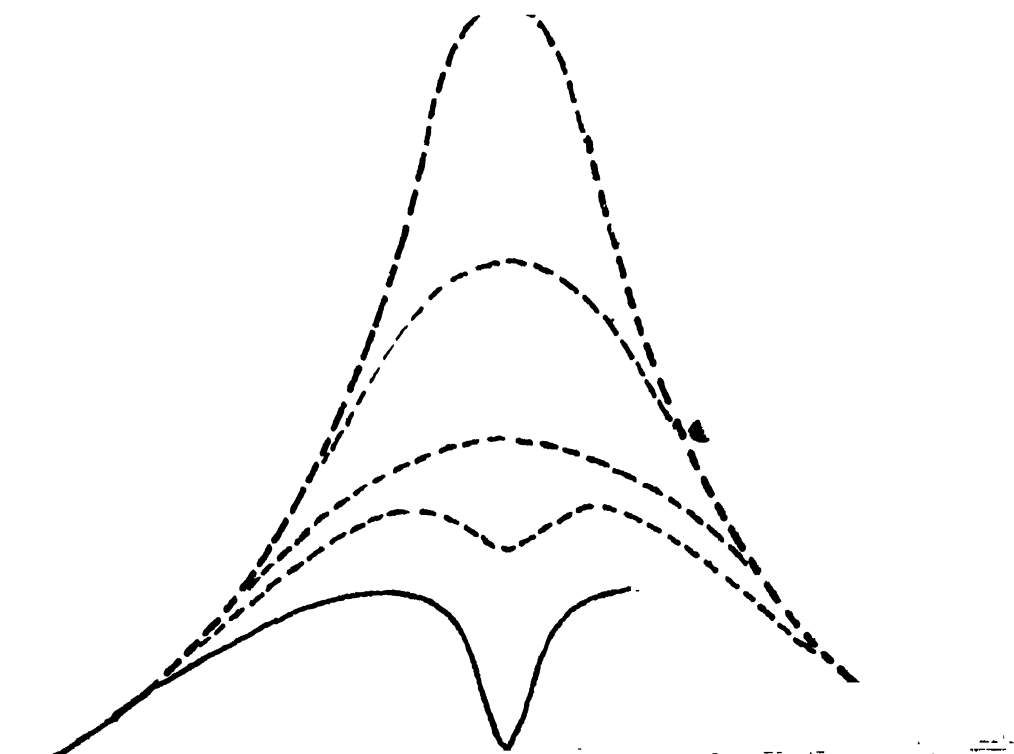


FIG. (ii)

Increasing density of the absorbing layer as the temperature is further raised, brings in more and more absorption at the centre, until more or less complete self-reversal sets in when each of the lines shows the appearance of a doublet.

This explains the apparent splitting phenomena where the two bright components are really the bright wings of each of the lines. The dark band at the centre is due to the higher degree of reversal at the core of the line.

Looking for the causes of the broadening of the lines we find that the most important of them is Doppler broadening. The calculated half intensity width due to Doppler broadening for the wavelength 5890 at 500°K comes to about 0.06 A. U. For the wavelength 5896 also the broadening will be practically the same. At the low pressure of neon (2 mm.) and the comparatively still lower pressure of sodium vapour, pressure broadening as well as resonance broadening will be negligible. Stark broadening by external field as well as by inter-atomic field also cannot be considered as the applied field is very low and the concentration of the charged ions is also small for the production of sufficient inter-atomic fields. As a matter of fact, when we compare the half width due to Doppler broadening, which is 0.06 A. U. with the highest separation of the components observed viz. 0.077 A. U. (Table I), we feel that the Doppler effect is quite sufficient to account for the broadening in this case. The broadening due to other causes, if any, will be negligible compared to this and will contribute little to the phenomena.

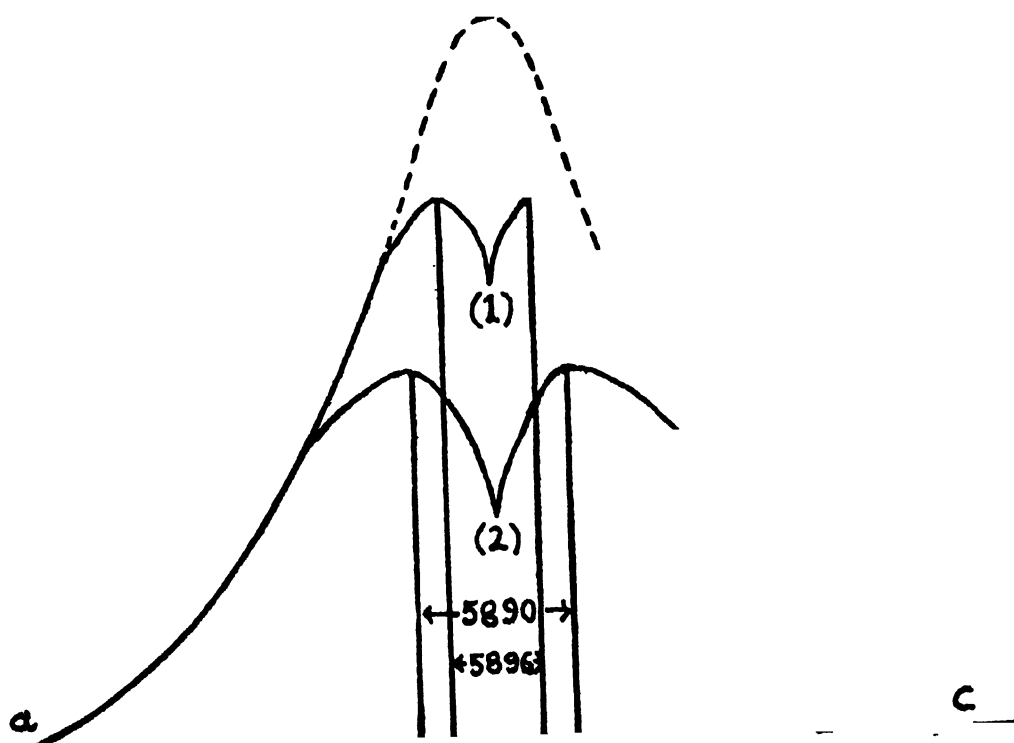


FIG. (iii)

The different separations observed for the components of the two D lines, (Table I higher for 5890 line than for 5896 line) in spite of having the same Doppler broadening, may be explained on the basis of more efficient absorption of the 5890 line than that of the 5896 line, the former being the chief in the principal series and the latter being a satellite. This is quite clear from the microphotometric record (Fig. I) where the central depression in the intensity curve for the 5890 line is more than that of 5896 line. Such a phenomena can be better explained by a diagrammatic sketch like Fig. iii. In this figure, the curve abc will represent the nature of the line without any self-absorption. The curve (1) is due to self-absorption which is less than the one shown by curve (2). The separation of the wings is greater for (2) than for (1).

The higher separation observed at the centre of the limb than at the top (Table I) may be attributed to unsymmetrical conditions of temperature or pressure of the sodium vapour at the two regions, which is quite likely as one is nearer the cathode region than the other.

REFERENCES

- (1) Tawde, Patil and Mehta, *Nature*, 156, 662, 1945.
- (2) Fonda and Young, *Journ. Optical, Soc. Amer.*, 24, 32, 1934.
- (3) Compton and Langmuir, *Rev. Mod. Phys.*, 2, 123, 1930.
- (4) Found, C. G., *Gen. Elec. Rev.*, 37, 269, 1934

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A NOTE ON THE INITIAL LEVEL OF THE HIGH PRESSURE BANDS OF CARBON

BY N. R. TAWDE, M. G. K. MENON AND G. K. MEHTA

THE upper level of the electronic transition which causes the high pressure bands of carbon, has not yet been fixed with certainty. These bands which have unequivocally been attributed to the C_2 molecule, have however, the $^3\pi_u$ ground state as the lower level in common with the C_2 Swan bands. Regarding the upper state, different authors have put forth different views. Johnson and Asundi¹ contend that it is a new triplet level of C_2 , other than that producing the Swan bands. According to their analysis, the high pressure system fits into a v'' progression with $v' = 0$ of a new band system of C_2 . On the other hand, Herzberg^{2,3,4} opines that they form bands of $v' = 6$ progression in the Swan system, and explains the great selectivity of the excitation of this upper level on the hypothesis of an inverse induced predissociation, so that the levels above $v' = 5$ are considered to be predissociated. Singh⁵ discusses in detail the points of this controversy and considers the view-point of Johnson and Asundi (loc. cit.) as the more probable.

In this connection, it is thought worthwhile to bring certain experimental results that we obtained recently in our laboratories, to bear on this very interesting controversy.

While studying condensed discharge through carbon monoxide in a π form of discharge tube, we happened to observe the high pressure bands of carbon simultaneously with the Swan bands and Angstrom bands which were being investigated. It was noted as a general observation that, an increase of pressure of CO in the discharge brought about a spectral transformation—namely an enhancement of the Swan system together with high pressure bands and simultaneous inhibition of the Angstrom bands. Measurements of the relative intensities of the Swan, along with high pressure bands, have been carried out by rigorous methods of photographic photometry⁶ followed in these laboratories for a number of years.

The results are tabulated below for the most intense bands in each system, viz. the Swan λ 5165 and high pressure λ 4680 as representatives of the systems. They are expressed on a relative scale on the basis of the (0,0) band of Swan system as 100.

TABLE I

BAND	5 mm	10 mm	15 mm	20 mm	25 mm	30 mm
Swan λ 5165	8.99	16.52	23.95	34.80	51.98	100.00
High pressure λ 4680	....	9.61	14.18	18.34	24.53	47.80
Ratio of Swan to High pressure	....	1.72	1.69	1.89	2.12	2.90

From the Table I, it is seen that both the systems undergo an increase in intensity with increase in pressure (Rows 2 and 3). To see whether the intensities of High Pressure λ 4680 A. U. band are in proportion to those of C_2 (Swan) we have calculated the ratios of their intensities at corresponding pressures in row 4 of Table I. A graph (Fig. 1) is drawn to show the intensities of the systems against pressures,

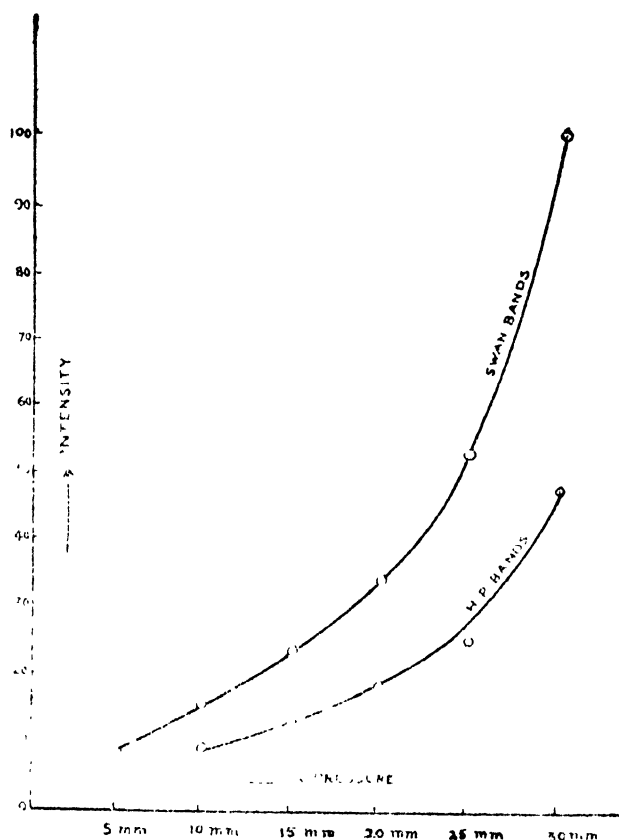


FIGURE 1

on the same pair of co-ordinates. This graph, and the approximate constancy of ratio in row 3 of Table I, show a considerable parallelism in the behaviour of the two systems. Also, the extrapolation of the Condon parabola for the Swan bands beyond the observed highest upper vibrational level $v'=5$, shows two intensity maxima at the level $v'=6$ in the bands (6,5) and (6,8). These are in conformity with the observations made by Herzberg (*loc. cit.*) that the intensity maxima exist at $v''=5$ and 8.

Franck-Condon principle normally excludes the possibility of two intensity maxima in a v'' progression arising at $v'=0$. Hence the high pressure bands would not fit in with this theoretical requirement on the hypothesis of Johnson and Asundi¹ and of Singh⁵ that they arise at $v'=0$ level in a separate system. But their possible assignment to $v'=6$ progression in the Swan system would not be contrary to the theoretical expectations and would be in agreement with Herzberg's considerations. Thus, from the standpoint of intensities observed in the systems and the influence which pressure causes on them, it seems tempting to assume after Herzberg, the high pressure bands as a $v'=6$ progression of the Swan bands.

There is also another side from which the problem can be discussed, and this is on considerations of the dissociation energy $D(C_2)$. On the hypothesis of an inverse induced predissociation as the mechanism of the production of the high pressure bands, and the consequent high populations of molecules in the $v'=6$ levels of the Swan system, Herzberg arrives at a value of 3.6 volts for the dissociation energy of the C_2 molecule. This however, seems to be at considerable variance with the value $D(C_2) \sim 5$ e.v. favoured by Gaydon⁷ as the more probable, from methods of graphical extrapolation. According to Gaydon, (loc. cit.) Herzberg's value may be reconciled with the above estimate of 5 e.v., if assumption is made that a part of the energy of recombination may be carried away by the third body in a three body collision which leads to the formation of the C_2 molecule in the upper state of the high pressure bands. Thus, as visualized by Gaydon, the formation of C_2 by three body collision will be the more probable one on the view of the estimate of 5 e. v. for the dissociation energy $D(C_2)$. In a recent paper, Herzberg⁴ maintains however, two body collision leading to recombination of carbon atoms.

Recently, from altogether different results obtained from vibrational intensity distribution in Swan bands, Tawde⁸ worked out the value of dissociation energy $D(C_2)$ by a graphical extrapolation method involving the observed statistical weights. His result for the dissociation energy of C_2 comes to be not less than 4.0 e.v., and is shown to be actually of the order 4.2 ± 0.1 e. v. from several independent observations.

The results of Gaydon and of Tawde mean that Herzberg's value of dissociation energy of C_2 is in error or if genuine, is to be explained on the basis of three body collisions, postulated for the formation of C_2 molecule. Taken along with quantitative evidence of intensity parallelism between the high pressure, and Swan bands of C_2 , obtained and illustrated above in this paper, (an equally weighty argument in Herzberg's favour), we are left with an open choice between the two hypotheses in connection with the high pressure bands, viz. that (1) they form an independent system of C_2 , or (2) a part of C_2 (Swan) arising at $v'=6$. A careful, complete rotational analysis of the system will most probably settle this very vexed question. Some work done in this field so far by Johnson and Asundi¹ and by Ciccone⁹ is only of a partial nature and needs to be followed up to a complete rotational structure analysis to cover all the bands in this system.

REFERENCES

- (1) Johnson and Asundi. *Proc. Roy. Soc. 124 A*, 668, 1929.
- (2) Herzberg. *Astrophys. J.* 89, 290, 1939.
- (3) Herzberg. "Molecular Spectra and Molecular Structure," Vol. 1. *Diatomic Molecules*. New York, 1939. pp. 472.
- (4) Herzberg. *Phys. Rev.* 70, 762, 1946.
- (5) Singh. *Ind. J. of Physics*. XIX, 167, 1945.
- (6) Johnson and Tawde. *Proc. Roy Soc.* 137 A, 575, 1932.
- (7) Gaydon "Dissociation Energies and Spectra of Diatomic Molecules." Chapman Hall Ltd. 1947. pp. 189-90.
- (8) Tawde. *Bom. Uni. Jour.* March, 1949.
- (9) Ciccone. *Nuovo. Cim.* Jan. 1942, 19.

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ATOMIC FUNCTION OF SOME GASES IN THE LIGHT OF REVISED VISCOSITY DETERMINATIONS

By V. D. MAJMUDAR AND V. S. OKA

THE kinetic theory of gases predicts the existence of a simple relation between the viscosity coefficient η , the thermal conductivity k and the specific heat C at constant volume. The relation, $k = \eta C_v$ was first obtained by taking account of the laws of distribution of velocities and of mean free paths of gas molecules. A more complete argument leads to the improved relation, $k = \epsilon \eta C_v$, where ϵ is an involved numerical constant, often referred to as *atomic function*.

Attempts are on record to explain theoretically the nature of the constant ϵ , the atomic function, but the explanations cannot be said to be very satisfactory. The lines on which they run are as follows :—

(i) Maxwell, on the assumption that the force between molecules varies as the fifth power of the distance between the centres, works out the value of atomic function as 2.5.

(ii) Chapman¹ and Enskog² assume the law of force to be of the form $F = \frac{\mu}{r^S}$ where μ and S are constants. The relation obtained by Enskog is

$$\epsilon = \frac{1 + \frac{(S-5)^2}{4(S-1)(11S-13)} + \dots}{1 + \frac{(S-5)^2}{2(S-1)(101S-113)} + \dots}$$

With this, the numerical value computed by Chapman and Enskog for the constant ϵ is approximately 2.5 for mon-atomic gases and less for polyatomic gases.

Eucken³ arrived at the same relation experimentally. Assuming that in the case of polyatomic gases, the transfer of translational energy is as suggested by Chapman and of the other forms of energy as governed by the relation, $k=2.5\eta C_v$, Eucken obtained the constant of atomic function in the form—

$$\epsilon = (9\gamma - 5)/4$$

where γ is the ratio of the two specific heats.

Hercus and Laby⁴ have also arrived from their experiments at a similar form of the expression for ϵ but with different numerical constants. Their expression is—

$$\epsilon = 2.816\gamma - 2.2$$

Pollock⁵ suggested an empirical formula giving

$$\epsilon = \frac{\gamma k}{\eta C_p} = 6.15 (\gamma - 1) \gamma$$

It can be gathered from the experimental results that the value of ϵ decreases with the number of atoms in the molecule. This fact suggests that it is not a constant as predicted by theory, but is in some way connected with the structure of the molecule. There is the fact that the experimental attempts to arrive at its value give diverse results. In view of the uncertainties both from the theoretical and experimental side, it was thought desirable to undertake investigations to revise experimentally some data on physical quantities that enable the derivation of the constant ϵ . Since 1913, very little work has been done in this direction. Only in a few cases measurement of viscosities or thermal conductivities of gases have been subjected to modern improved techniques. In an attempt to revise the value of electronic constant, e , Majmudar and Vajifdar⁶ measured the viscosity of air by sensitive optical manometer capable of giving accurate results. The improved value of viscosity of air and the electronic charge e computed from it, have since been incorporated in modern books of constants and standard literature.⁷ The method used has got its importance in other gases whose viscosities, if revised, would throw further light on the atomic function ϵ introduced above.

EXPERIMENTAL

It is therefore proposed in this investigation to extend the method to some other gases for obtaining values of the coefficient of viscosities under improved experimental technique, especially with a view to examine the function ϵ . The gases chosen were air, oxygen, nitrogen, carbon monoxide, methane and ethane. The last three were particularly chosen with a view to obtain more information about viscosity in relation to structure or complexity. The details of the method of viscosity have been fully explained in the paper of Majmudar and Vajifdar⁸. The factors responsible for giving the accurate measure of viscosity coefficient are the use of extremely sensitive optical manometer which reads pressure changes during interval of the flow of gas through capillary tube accurately and the employment of the automatic time recorder which reduces errors due to personal factor to a minimum.

All the possible care was taken to obtain the gases in a pure state and free from water vapour as far as possible. The organic gases in particular gave much trouble in this direction. Want of space, however, does not permit full description of the processes employed.

RESULTS

The viscosity coefficients were measured at room temperature and converted to standard temperature of 0°C . The values are entered in the columns of the following table.

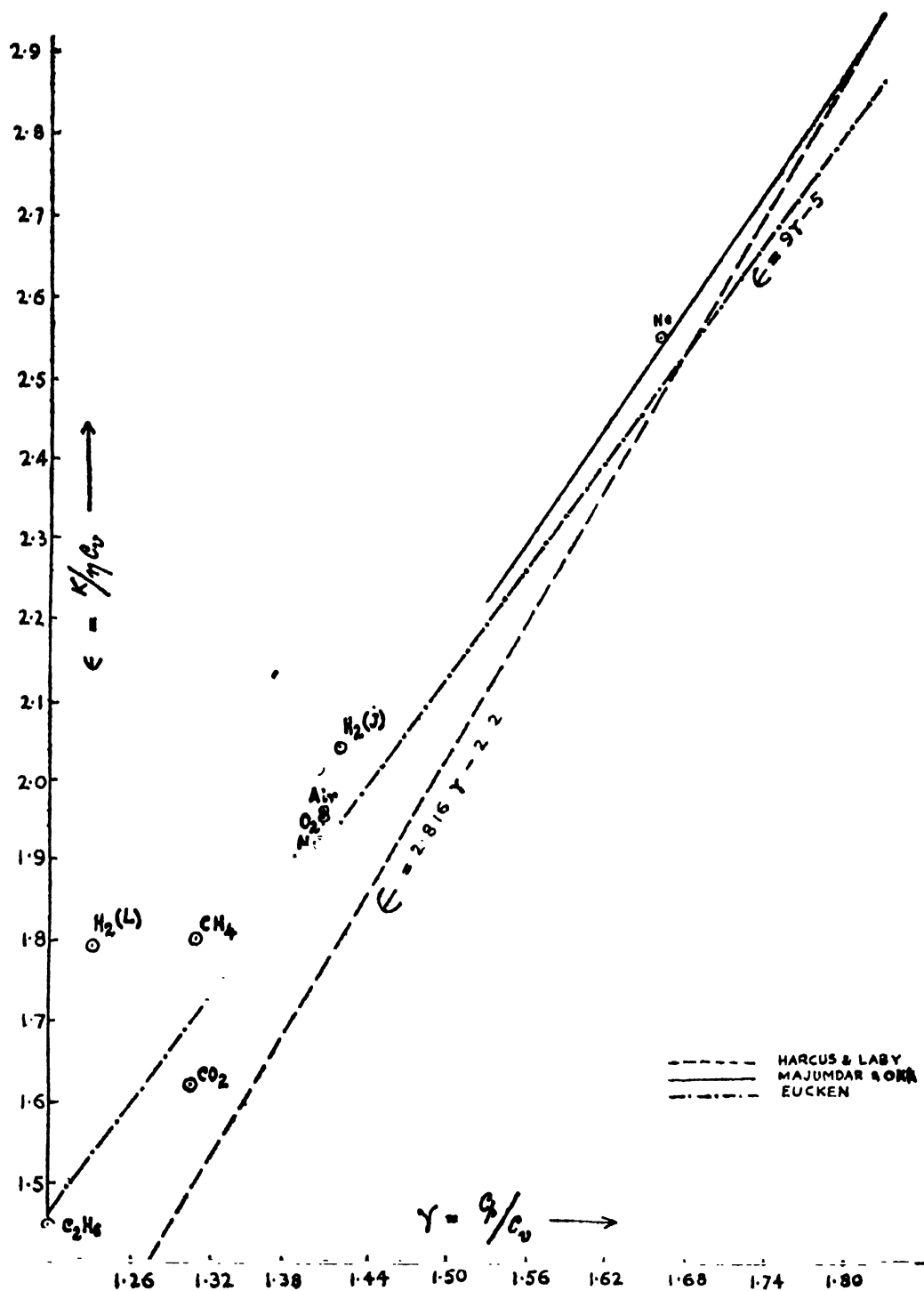
TABLE I

Gas	$K \times 10^7$	$\eta \times 10^7$	C_v	γ	$k/\eta C_v$
1. Ethane	436	877	0.3451	1.202	1.44
2. Carbon Dioxide ..	343	1371	0.1543	1.295	1.621
3. Methane	721	9743	0.412	1.31	1.796
4. Nitrogen	566	1662	0.1770	1.4	1.924
5. Air	578	1721	0.1708	1.4	1.966
6. Oxygen	583	1911	0.1563	1.402	1.953
7. Hydrogen.. ..	4130	835	2.42 (J)*	1.42 (J)*	2.044
8. Neon	1092	2975	0.144	1.666	2.549

*(J) Represents value from Jean's book.¹⁰

The other constants that lead to the function ϵ are the conductivity k and the specific heat C_v at constant volume. To obtain these experimentally would have considerably increased the scope of this investigation. Hence the constants have been adopted from standard references⁹ and entered in columns 2 and 4 respectively of the table. By employing these known results, and the measured value of η the value of $\epsilon = \frac{k}{\eta C_v}$ for each of the chosen gases, was computed.

The values of the constant γ are also entered in the table I in the column 5 in order to see the exact connection of it with ϵ . The relation of γ with ϵ is graphically represented in the following figure, the plot being shown by points marked (\circ), and thick continuous line.



DISCUSSION

If the relation between ϵ and γ is assumed to be linear, we can write it in the form $\epsilon = a + b \gamma$ where the values of a and b can be determined by the method of least squares so as to fit up ϵ and γ closely in a straight line graph. The computed values of a and b by this method come to be $a = -1.483$, $b = 2.418$, so that the relation ultimately reduces to

$$\epsilon = 2.418 \gamma - 1.483$$

or
$$\epsilon = \frac{9.672 \gamma - 5.932}{4}$$

resembling the usual forms of Eucken and of Hercus and Laby. We have to note here that hydrogen values have not been made use of in this fit-up of the graph, because of the contentious nature of constants. This point will be critically examined in the latter part of the discussion.

In order to see the closeness, if any, of this relation with the existing ones, the graphical representation of the formula of Eucken $\epsilon = \frac{9\gamma - 5}{4}$

and Hercus and Laby $\epsilon = 2.816 \gamma - 2.2$ is given on the same graph as that of the expression derived above. Examination of these graphs shows that most of the observed points lie closer to the present form than to those of Eucken and of Hercus and Laby. In the region of the gases investigated, the relation of Hercus and Laby gives a wide departure from the experimental results, while it predicts a closer approach at much higher value of γ and ϵ (where we have not obtained any revised viscosity data). The converse happens in the case of Eucken's expression which agrees better for lower values of these quantities. This represents the relative position of the three expressions which we shall now further discuss with reference to hydrogen.

If primary gases can be considered to be any guide in testing the correctness or the approximations of the empirical relation then we might use the results on hydrogen, the elemental gas, to see the relative merit of the three relations under discussion. With value of $\gamma = 1.42$ and $C_v = 2.45$, the point for hydrogen H_2 (J) on the graph falls closer to the line represented by relation derived in this paper, than to either of the two relations of Eucken and Hercus and Laby. On the other hand if we adopt the value (L. & B.'s constants)⁸ of $\gamma = 1.23$ and $C_v = 2.76$ for hydrogen, the graphical point H_2 (L) locates ridiculously away from either of three graphical lines. In the light of these findings, more reliance has to be placed on the values used by Jeans than Landolt's constants. If this is not so and equal weight is to be given to both sets of values, then hydrogen offers a case for further investigations involving redetermination of the two specific heats under improved experimental conditions and similarly of the thermal constants also. Though on relative considerations, the suggested expression appears to be better than the other two, it is difficult to assess its absolute merit unless we possess revised data on thermal conductivities of about the same precision as claimed for viscosities.

Thus subject to redetermination of the thermal constants of the gases included under this investigation, as pointed out above, the atomic function $\epsilon = \frac{9.672 \gamma - 5.932}{4}$ is the nearest approach to the available experimental results.

In the preparation of this paper we have received considerable guidance of Dr. N. R. Tawde and help from Mr. K. S. Korgaonkar, our colleagues to whom we offer grateful thanks.

ABSTRACT

Accurate experimental determination of the viscosities of air, hydrogen, oxygen, nitrogen, neon, carbon dioxide, ethane and methane have been made by a method involving sensitive optical and mechanical devices. The values so determined have been utilized for deriving the atomic function ϵ in relation to γ . This relation works out as—

$$\epsilon = \frac{9.672 \gamma - 5.932}{4}$$

The relative merit of this with respect to the expressions of Eucken and of Hercus and Laby has been discussed.

The place of hydrogen in the above relation has been examined in view of the differing values of its constants. It appears that redetermination of the two specific heats of hydrogen is necessary.

REFERENCES

1. Chapman, Phil. Trans. Roy. Soc. *211A*, 433, 1912.
" " " 216A, 279, 1915.
2. Enskog, Kinetische Theorie der Vorgänge in massig verdünnten Gasen, Inaug. Dissertation, Upsala, 1917.
3. Eucken, Phys. Zeit. *14*, 324, 1913.
4. Hercus & Laby, Roy. Soc. Proc. *95*, 190, 1919.
5. Pollock, Roy. Soc. N. S. Wales, Jour. & Proc. *53*, 116, 1919.
6. Majmudar & Vajifdar, Proc. Ind. Acad. Sc. *8*, 171, 1938.
7. Stranathan, Particles of Modern Physics, (Blakiston Co.), Philadelphia 1942, p. 60.
8. Majmudar & Vajifdar, Bom. Uni. J. *7*, 27, 1938.
9. Landolt & Bornstein's Tables, 1935.
10. Jeans, Kinetic Theory of Gases, 1940 (Camb. U. P.), p. 279.

CHARACTERISTICS OF THE FIRST POSITIVE NITROGEN BANDS IN A HIGH TEMPERATURE SOURCE

BY N. R. TAWDE AND V. D. DESAI

IN a note¹ published some time ago, the authors made a brief reference to the peculiar development of the first positive bands in a point-o-lite lamp. This lamp is usually employed as a point source for continuous radiation especially in absorption work. It is an arc source in the atmosphere of nitrogen and develops a very high temperature of the order of $2700^{\circ}\text{K}^{1a}$. It was thought worthwhile to examine if nitrogen gas within this high temperature arc space, gives any of its characteristic spectra, either molecular or atomic. Preliminary examination showed that it gave bands of ionised nitrogen molecule N_2^+ very brilliantly. Further careful examination indicated, in a diffuse background, the presence of the first positive bands of normal nitrogen. Childs² has already investigated the N_2^+ bands in a point-o-lite for their rotational structure. But the first positive bands in this source do not seem to have received attention. Further it is a common observation while examining the spectra of nitrogen that generally the two band systems of N_2 , viz., the first positive and second positive occur simultaneously. But it was curious to note that in this case it was not so. Hence the study of the point-o-lite source appeared interesting as a high temperature source for the nitrogen first positive bands and on account of the above peculiar behaviour.

The first positive bands are moreover known to be associated with aurora, night sky and afterglow and form a subject of investigation by a number of workers such as Raleigh³, Strutt and Fowler⁴, Jevons⁵, Kaplan⁶, Cario and Kaplan⁷, Okubo & Hamada⁸, and others. The selective effect shown by these bands under certain conditions, especially in active nitrogen makes them a fascinating field of study. Active nitrogen has been a subject of absorbing interest by Raleigh, Willey⁹, Kaplan¹⁰, Sponer and lately by Mitra¹¹, on the theoretical side. In spite of the various mechanisms proposed for it, it is still a mysterious phenomenon. Any study of the spectral characteristics of the first positive bands would add to the elucidation of this very complex topic of active nitrogen. In this connection, the quantitative study of the relative intensities of these bands appeared to be of great consequence. Broad conclusions of such a study have been presented in an advance note¹ of the authors. In this paper it is proposed to give details of the investigation with a full critical discussion of the several points arising out of the results.

The point-o-lite was 230 volt—100 Watt glass bulb (Ediswan). The lamp was excited by the special gear and switch unit supplied with it. The spectrograph used was a Hilger C. D. instrument adjusted to record on the plate the first positive system so as to include as much as possible of its red end side. The arc space of the point-o-lite was of very small dimensions and on this account when it was focussed on the slit the resulting spectrum was masked by intense continuous radiation of the nearer bright tungsten bead. A very much enlarged image of the portion between the bead and the filament was therefore thrown on the slit. This avoided to a certain extent, the continuous radiation of the neighbouring incandescent parts, but did not entirely produce on the picture, clear band heads suitable for measurement. Apertures of various sizes were therefore tried in front of the lamp and this device produced to a great extent the contrast needed to show clearly the bands without much disturbing background effect of diffuse light.

In order to examine the high temperature effect, it was necessary to obtain some source under lower temperature conditions. This was chosen to be the positive column of a discharge in pure nitrogen excited in a tube of 1 mm. capillary bore, under constant conditions of pressure voltage and current. The temperature developed in such a tube is not expected to be more than about 200°C.

The spectra from both the point-o-lite and the discharge column viewed end-on, were recorded on Ilford Rapid Process Panchromatic (backed) plates. Intensity marks were caused to be laid on the plate, side by side with each of the spectrum strips by exposure to a calibrated standard lamp of known energy distribution through a step slit. Independent sets of plates were obtained for each kind of spectrum source and they were microphotometered on a self-recording instrument for the computation of peak intensity values at each of the band heads. Full technique of the method is available from the work of Tawde & Patel¹⁸. Owing to development of rotational structure of high quanta and some degree of diffuseness of the picture given by point-o-lite source, some difficulty was experienced in identifying the band heads and in eliminating the disturbing background intensities. In order to help the correct identification, a picture of the discharge tube spectrum giving clear unmixed first positive bands was impressed side by side with that of the point-o-lite.

THE RESULTS

The results of the final corrected intensity values have been expressed on the relative scale of 1000 for the (6,3) band of the system which happened to be the strongest in the discharge. They are recorded in Table (I) for both the excitation sources. The column 1 in it gives the band with its quantum numbers, the columns, 2 & 3 the intensities I_p and I_d of the bands in the point-o-lite arc and discharge tube respectively, the columns 4 and 5, the I_p/I_d values and column 5, the ratio of the intensity in point-o-lite to that in discharge.

TABLE I
I & I/ ν^4 values

Band	Intensities I		I/ ν^4 values		Ratio of Intensities Point-o-lite/ Discharge
	Point-o-lite Arc I _p	Discharge Tube I _d	Point-o-lite Arc I _p / ν^4	Discharge Tube I _d / ν^4	I _p /I _d
5,1	223.3	106.9	31.5	15.1	2.08
5,2	1258	993.8	254.2	200.7	1.26
6,1	118.4	.....	11.6	.....	.....
6,2	220.5	978.6	29.6	132.8	0.22
6,3	1000	1000	192.4	192.4	1.00
7,2	117.8	.....	11.2	.....	.....
7,3	203.1	820.6	26.6	107.3	0.24
7,4	745.9	837.0	136.9	153.6	0.89
8,3	98.5	49.6	9.1	4.6	0.20
8,4	189.4	774.5	23.9	97.7	0.24
8,5	606.8	780.3	106.3	136.7	0.78
9,4	95.9	79.2	8.6	7.1	1.21
9,5	186.9	772.7	22.7	94.0	0.24
9,6	505.8	779.1	84.6	130.2	0.65
10,5	95.2	105.9	8.4	9.3	0.90
10,6	182.8	770.3	21.5	90.5	0.24
10,7	230.1	777.3	36.8	124.3	0.29
11,6	94.9	117.1	8.1	10.0	0.81
11,7	172.0	761.4	19.5	86.4	0.22
11,8	94.5	769.1	14.4	117.6	0.12
12,7	87.4	102.0	7.3	8.5	0.86
12,8	171.4	757.7	18.8	83.1	0.22
12,9	77.7	88.6	11.4	13.0	0.86

From the above values, the excitation functions $\Sigma I/\nu^4$ for the different ν' levels have been calculated and they are recorded in table II below for both the point-o-lite and the discharge tube.

TABLE II
Excitation functions $\Sigma I/\nu^4$

Initial level ν'	Point-o-lite lamp	Discharge tube
5	285.7	215.8
6	233.9	325.2
7	174.7	260.9
8	139.3	239.0
9	115.9	231.3
10	66.7	224.1
11	42.0	214.0
12	37.5	104.6

The results of the two intensity distribution have been illustrated for comparative study in Fig. 1, where the lengths of the vertical lines represent the relative intensities for different bands on a proportionate scale.

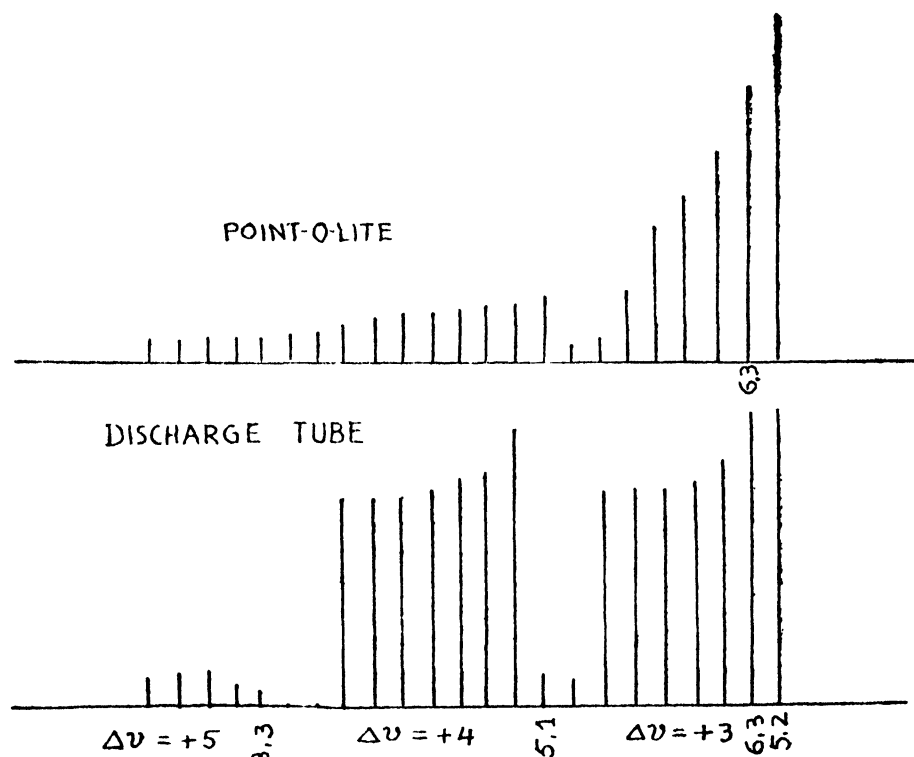


FIG. 1

DISCUSSION

The special point to note in connection with the distribution is the marked selection of the bands in 3 well-defined groups of intensities in the case of discharge tube spectrum. This is an accepted feature of such an excitation. Out of these three groups, the groups belonging to sequences $\Delta v = +3$ and $\Delta v = +4$ have practically the same intensity level separated by very feeble intensities of (12, 9) and (5, 1) bands (see Fig. 1). The third group belonging to $\Delta v = +5$ is about 1/10th of the intensity of each of the two other groups. This is separated from the sequence $\Delta v = +4$ by two bands (6, 1) and (7, 2) which are too feeble to appear in the discharge. Looking into the point-o-lite spectrum intensities, we find that the above feature is entirely absent and there is no selection of any particular group or sequence of bands. Another distinguishing characteristic of the two distributions is the behaviour of the individual bands in the above groups or sequences. While in the case of discharge, the individual bands of sequences maintain practically the same intensity level, those in the point-o-lite give varying intensity slopes. Beginning with very steep intensity slope in sequence $\Delta v = +3$, the slope value diminishes with increase in Δv until at $\Delta v = 5$, it is almost flattened. This is illustrated in Fig. 2 below.

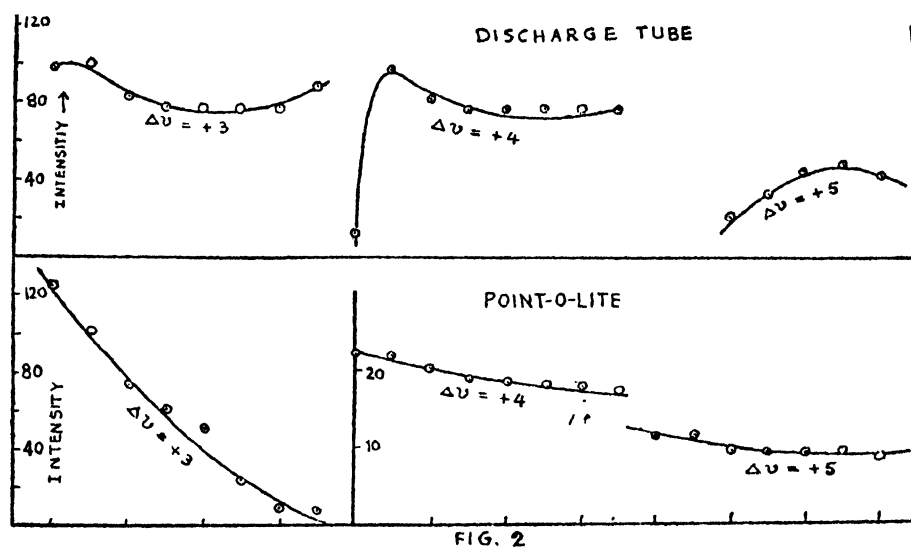


FIG. 2

The relative efficiency of the point-o-lite arc to excite the first positive nitrogen bands is found to be nearly 60% of the low temperature discharge column. This can be easily deduced from the excitation functions of Table II. In view of the fact that the processes of excitation are not very similar in the two cases, it is difficult to say whether the low efficiency of the lamp is only a temperature effect.

The lamp is essentially an arc source in which the arc is struck by initial ionisation by the electrons from the heated filament acting as a cathode. The lamp comes filled with nitrogen at a sufficiently high pressure and on striking the arc, the first green-violet flash resembles the negative glow in an ordinary discharge. Bands due to ionised molecule N_2^+ have their origin in this glow. With the increase in temperature of the lamp on stabilization, these radiations of negative nitrogen persist in the arc length, which is of the order of a min. or so.

The pressure of negative nitrogen bands shows that the exciting electrons generated by the hot filament are accelerated in its close neighbourhood to the extent of 19.6 e.v. or more which is the excitation potential of the ionised molecule. The first and the second positive bands have excitation potentials of the orders of 9.4 and 13.0 e.v. respectively, hence we should also expect excitation of these bands, as low energy electron (9 to 13 e.v.) will also be present. It was however noted that in addition to N_2^+ ($B \ ^2\Sigma \rightarrow X \ ^2\Sigma$) bands, only the bands belonging to N_2

(1st positive) system were present as a somewhat weaker and diffuse spectrum in the background. This is, as it should be, except for the complete absence of the second positive system. Similar observations have been made by Childs² who, while investigating the negative nitrogen bands in a point-o-lite did not notice the spectrum of second positive system. The point-o-lite being a glass bulb no access could be had to U. V. to identify nitrogen systems in that region. We shall see how these observations can be accounted for.

Three electronic states are involved in the emission of the first positive and the second positive systems viz., $C^3\pi$, $B^3\pi$ and $A^3\Sigma$, the former two giving the second positive and the latter two, the first positive. The negative nitrogen bands of N_2^+ involve the transition between the states $B^3\Sigma$ and $X^3\Sigma$, the dissociation energies of which according to Mulliken's data are respectively 3.7 and 6.8 volts. The dissociation energies of the three states of normal molecule are not known with certainty. But from the Birge-Sponer curves given by Jevons¹¹, the dissociation energies of $B^3\pi$ and $A^3\Sigma$ states should be not less than about 6 volts. The Birge-Sponer curve available for the $C^3\pi$ state, the upper level of the second positive system compares with that of $B^3\Sigma$ of N_2^+ and it is most likely that its dissociation energy is a little less than that of $B^3\Sigma$ i.e. 3.7 volts. If so, it is quite probable that the absence of the second positive system is due to the dissociation of the normal molecule in its upper $C^3\pi$ state. As the lamp has a very high temperature of the order of 2700°K, it is not unlikely that it supplies the thermal energy of the order of about 80 to 85 Kilo-calories to the gaseous column for dissociation in this state. Another contributory cause may be the high sensitivity of the $C^3\pi$ and $B^3\pi$ states to predissociation discussed at length by Gaydon¹² in his recent publication. Beyond disappearance of second positive system on this account and on the view of dissociation energy discussed above, further consequence of predissociation is the diffuseness of the first positive band structure for which there is some evidence from our results.

Active Nitrogen

Duffendack¹⁶ has noted in one of his papers that tungsten at high temperature reacts with active nitrogen and forms a brownish deposit. This fact coupled with the failure of our lamp to give the same original efficiency after some use led us to look into it in terms of Duffendack's findings particularly on account of tungsten filament of the lamp at the high temperature attained by it. As the lamp became unserviceable owing probably to the above cause we discarded it and tried to investigate the radiations in the light of active nitrogen. Okubo and Hamada¹⁷, have shown that the lower the temperature of the emitting gas, the better the definition of the spectrum and sharper the selective enhancement in the first positive bands at about $v'=6$ and $v'=11$. Here we may consider the gas in the point-o-lite at a high temperature and the gas in the discharge in tube at low temperature and then see by taking the ratio of the intensities at different v' levels in discharge column and the point-o-lite whether the findings of Okubo & Hamada could be verified in a general way. The following table III gives the ratio of the intensities $\left(\frac{\sum I_d}{\sum I_p}\right)$

for levels v' of the system, where ΣI_d = sum of intensities of bands in discharge column and ΣI_p = the sum of intensities in point-o-lite. It may be seen from the results that there is distinct rise in the value of the ratio at $v' = 11$ which is very significant.

TABLE III
First Positive System

V'' progression with $V' = \dots$	5	6	7	8	9	10	11	12
Value of $\Sigma I_d / \Sigma I_p$	0.74	1.48	1.55	1.79	2.07	3.26	4.56	2.82

The enhancement in the low temperature condition (i.e. discharge) at $v' = 11$ as seen by the figures of the ratios in the above table is quite conspicuous and cannot be missed. This coincides with the distribution in the α -bands of active nitrogen and shows that at higher temperature of the gas, the selective effect disappears and the intensity distribution becomes more flat. The coincidence with active nitrogen needs some examination. It is quite likely that when the first arc-glow, after switch-on of point-o-lite appears, the gas in the arc space is relatively at lower temperature and may be productive of active nitrogen spectrum. The initial luminosity of the glow disappears with the subsequent rise in temperature and this is, as one should expect on the basis of the observations of Cario & Kaplan¹ on the afterglow of active nitrogen. If the spectral distribution in the initial glow is found to correspond to that in the afterglow spectrum of active nitrogen, we should have a very significant data in our possession to test the correctness of the above views. As to whether active nitrogen can at all be traced to point-o-lite arc excitation, we have the observations of Duffendack¹⁶ as to its occurrence in low voltage arc. The action of such an arc on the nitrogen has been shown by him to be similar to that of condensed discharge. Recently Mitra¹⁸ has given a theory of active nitrogen. According to him active nitrogen is positive ions of nitrogen molecule in the $N_2^+ (X^2\Sigma)$ state. In the present case, i.e. in the point-o-lite arc the spectrum being rich in bands of first negative system, we may assume that there is sufficient number of positive nitrogen ions in the above ground state which bring about an active nitrogen condition which, though feeble under the high temperature condition, is nevertheless identifying in the first positive spectrum.

Considering the effect of voltage on nitrogen systems, the bands should rapidly increase in intensity above ionising potential of nitrogen. According to Duffendack,¹⁶ the effect of increase in voltage on first positive should be slight, but second positive system should disappear, and this is as found in these experiments, the effect having been sufficiently discussed in a previous paragraph on different considerations. The fact comes out that even at such a high temperature of the point-o-lite, the nitrogen molecule is ionised without dissociation and this is shown by the non-appearance of atomic lines of nitrogen in our spectrum. Duffendack hardly found 3 or 4 atomic lines from nitrogen arc in a furnace at a temperature of 2500°C which proves very small degree of dissociation of

the molecule in agreement with the conclusions of Langmuir¹⁸. Even if there is small dissociation, according to Merton and Pilley¹⁹, conditions for production of line spectra will not be favoured at pressures of the order available in point-o-lite and the molecular spectrum will predominate.

REFERENCES

- (1) Tawde and Desai, *Science and Culture*, 1941, 7, 270.
- (1a) Tawde and Unvala, *Bom. Univ. Jour.*, 1948, 16, 79 ;
- (2) Childs, *Proc. Roy. Soc.*, 1932, 137A, 641.
- (3) Raleigh, *Proc. Roy. Soc.*, 1911, 85A, 219 ; 1935, 151A, 567.
- (4) Strutt & Fowler, *Proc. Roy. Soc.*, 1912, 86A, 105.
- (5) Jevons, *Proc. Roy. Soc.*, 1914, 89A, 187 ; 1915, 91A, 120.
- (6) Kaplan, *Phys. Rev.* 1920, 33, 154.
- (7) Cario and Kaplan, *Zeit. f. Phys.*, 1929, 58, 769.
- (8) Okubo and Hamada, *Phil. Mag.*, 1928, 5, 372.
- (9) Willey, *Jour. Chem. Soc.*, 1927, page 2188 & 2831 ;
1930, page 336 and 1146.
- (10) Kaplan *Phys. Rev.*, 1938, 51, 241.
- (11) Spomer, *Zeit. f. Phys.*, 1925, 34, 622 ; 1927, 41, 611.
- (12) Mitra, *Science & Culture* 1944-45, 10, 133 ;
"Active Nitrogen"--A new Theory--Calcutta, 1945.
- (13) Tawde & Patel, *Bom. Univ. Jour.*, 1937, 6, 29.
- (14) Jevons ; "Report on Band Spectra of Diatomic Molecules," p. 194, (Physical Society, London, 1932).
- (15) Gaydon, "Dissociation Energies", Chapman & Hall, Ltd., 1947, p. 156.
- (16) Duffendack, *Phys., Rev.* 1922, 20, 665.
- (17) Okubo & Hamada, *Phys. Rev.*, 1932, 42, 795 ; *Phil. Mag.* 1933, 15, 103.
- (18) Langmuir, *J. Am. Chem. Soc.*, 1915, 37, 417 ; 1919, 34, 860.
- (19) Merton and Pilley, *Proc. Roy. Soc.*, 1925, 107A, 411.

SHRINKAGE OF COTTON YARN

BY M. G. KARNIK AND S. C. DEVADATTA

THE shrinkage of cotton yarn caused by treatment with aqueous solutions of salts, acids and alkalies has received a wide technical application such as the production of (1) Special textile finishes (2) Vulcanised fibres (3) Increased affinity to colouring matters (4) Vegetable parchment, etc. The well known process of mercerisation owes its significance to the shrinkage and luster caused by the aqueous solutions of Sodium hydroxide. The reagents like zinc-chloride, calcium-thiocyanate, sulphuric and phosphoric acids are also of considerable importance in the textile industry and have been known to act as effective swelling and dispersing agents. For the industrial application of these reagents it is desirable to get the maximum effect in the minimum of time.

The study of shrinkage of yarn in these reagents has recently been made at 25°C by Dr. G. S. Kasbekar and S. M. Neale.¹ The present investigation was undertaken with a view to study the effect of higher temperatures on the shrinkage of yarn in the solutions of ZnCl_2 , $\text{Ca}(\text{CNS})_2$, H_2SO_4 and H_3PO_4 . A wide range of concentrations of these reagents was used and the experiments were conducted at 40°C, 50°C, 60°C, and 75°C.

EXPERIMENTAL

The solutions of various concentrations of the swelling agents were prepared and their exact strengths were determined by methods described by G. S. Kasbekar and S. M. Neale.¹

A two fold yarn of 28's count of Sakillaridis cotton, previously bleached was employed. The yarn, about 10 cm. in length was suspended in the shrinkage apparatus as shown in fig. 1. The apparatus was kept in a water thermostat at the temperature of the experiment $\pm 0.01^\circ\text{C}$ so that the level of water was well above the yarn. The exact length of the yarn was measured by the use of Cathotometer, the scale of which was graduated to read 0.002 cm. The shrinkage medium, preheated to the required temperature was then introduced into the apparatus and the length of the yarn was again measured at different intervals of time until either the yarn broke or showed no further marked shrinkage.

RESULTS AND DISCUSSION

The maximum percentage shrinkage and the time for maximum shrinkage of cotton yarn in the solutions of various concentrations of two salts viz. zinc-chloride and calcium thiocyanate and two mineral acids viz. sulphuric and phosphoric have been determined. The results obtained are recorded in tables I to IV and shown graphically by curves A1 to A8.

TABLE I

Shrinkage of yarn in solutions of Zinc-Chloride

Concentration of solution percentage by weight	at 40°C		at 50°C		at 60°C		at 75°C	
	Maximum percentage shrinkage	Time for maximum shrinkage in hours	Maximum percentage shrinkage	Time for maximum shrinkage in hours	Maximum percentage shrinkage	Time for maximum shrinkage in hours	Maximum percentage shrinkage	Time for maximum shrinkage in hours
21.00	1.71	0.25	2.28	0.20	3.04	0.18	3.50	0.15
30.80	2.44	0.32	3.48	0.20	4.46	0.20	5.00	0.15
40.38	3.30	0.50	4.10	0.45	4.81	0.38	5.80	0.40
50.10	3.58	0.92	4.76	0.75	5.75	0.50	7.00	0.40
57.00	5.30	0.75	6.85	0.75	8.40	0.45	9.60	0.38
62.00	10.10	8.00	13.55	5.50	15.50	5.00	18.07	4.25
66.00	20.32	12.50	22.75	10.00	25.33	7.75	29.45	5.00
71.10	35.00	16.00	39.50	12.50	42.00	10.00	44.50	7.25
73.00	57.06	17.25	59.25	15.00	63.10	12.00	64.02	10.00
75.01	55.00	25.00	56.50	20.00	58.00	16.25	58.87	10.00

TABLE II

Shrinkage of yarn in solutions of calcium thiocyanate

Concentration of solution percentage by weight	at 40°C		at 50°C		at 60°C		at 75°C	
	Maximum percentage shrinkage	Time for maximum shrinkage in hours	Maximum percentage shrinkage	Time for maximum shrinkage in hours	Maximum percentage shrinkage	Time for maximum shrinkage in hours	Maximum percentage shrinkage	Time for maximum shrinkage in hours
19.08	0.70	5.00	0.75	5.00	1.00	2.50	1.30	2.00
32.45	1.20	10.00	1.40	7.50	1.70	4.00	2.10	3.5
51.00	7.00	20.0	7.51	16.0	8.10	10.0	8.70	6.0
56.50	9.10	40.5	9.55	30.0	10.00	22.0	10.45	18.0
57.87	9.80	45.0	10.00	30.0	10.51	20.0	11.00	15.75
58.12	10.20	48.0	10.40	38.0	11.00	30.0	11.30	26.0

TABLE III

Shrinkage of yarn in solutions of sulphuric acid

Concentration of solution percentage by weight	at 40°C		at 50°C		at 60°C		at 75°C	
	Maximum percentage shrinkage	Time for maximum shrinkage in minutes	Maximum percentage shrinkage	Time for maximum shrinkage in minutes	Maximum percentage shrinkage	Time for maximum shrinkage in minutes	Maximum percentage shrinkage	Time for maximum shrinkage in minutes
21.02	0.804	10.00	1.09	5.00	1.25	4.75	1.50	3.88
39.72	1.50	7.00	1.74	3.88	1.85	3.00	2.00	2.88
50.60	2.10	5.00	2.69	3.25	2.91	2.50	2.72	1.75
59.10	5.45	4.00	3.40	3.50	2.05	2.25	1.10	1.50
60.98	10.00	3.75	4.50	3.12	2.00	1.63	breaks	..
61.50	22.00	2.50	10.00	1.88	breaks	..	..	..
63.86	57.18	0.75	5.12	1.12	..	..	..	..
66.60	25.00	0.25	breaks	..	..	..	..	..
69.80	breaks	..	..	..	..	..	..	..

TABLE IV

Shrinkage of yarn in solutions of phosphoric acid

Concentration of solution percentage by weight	at 40°C		at 50°C		at 60°C		at 75°C	
	Maximum percentage shrinkage	Time for maximum shrinkage in minutes	Maximum percentage shrinkage	Time for maximum shrinkage in minutes	Maximum percentage shrinkage	Time for maximum shrinkage in minutes	Maximum percentage shrinkage	Time for maximum shrinkage in minutes
52.00	1.02	30.00	2.60	22.50	1.50	15.00	1.01	5.00
57.00	2.00	25.00	3.16	18.50	1.80	11.00	1.40	4.75
70.80	3.90	20.00	4.85	18.50	2.09	8.50	1.71	4.00
77.10	8.00	20.00	10.74	20.00	3.76	6.25	2.00	2.75
80.01	15.00	20.00	19.54	17.50	11.23	5.25	6.50	2.25
82.80	55.40	10.00	58.65	4.88	28.46	4.00	3.58	2.00
87.50	25.20	10.00	29.05	5.00	18.50	2.63	2.88	0.63
89.60	21.16	6.00	26.09	2.81	15.28	0.722	breaks	..

It will be observed that the maximum percentage shrinkage and the time required to attain the maximum, in the solutions of zinc-chloride and calcium thiocyanate increase with the increase in concentration. The percentage shrinkage increases with the rise in temperature. In zinc-chloride solutions the percentage shrinkage of yarn is considerably more at 40°C than at 25°C for all concentrations. The further increase in shrinkage with temperature, however, is not very appreciable. But the time required to attain the maximum shrinkage is considerably reduced as the temperature is increased indicating thereby the increase in the rate of shrinkage at higher temperatures.

It is found that there is no appreciable shrinkage of yarn in solutions of calcium-thiocyanate at any of the temperatures tried in this investigation. The increase in percentage shrinkage with the temperature is also not quite appreciable. The highest shrinkage of 11.30 per cent is attained in the concentration of 58.12 per cent at 75°C.

It will be seen from the results in table III that the shrinkage of yarn in solutions of sulphuric acid increases with the concentration, reaches a maximum and then decreases. At 40°C the yarn shows the maximum shrinkage of 57.18 per cent in the concentration of 63.86 percent, while in the solution of 69.80 percent strength and beyond the yarn breaks immediately. In dilute solutions the percentage shrinkage increases with the temperature upto 50% concentration. In the concentration of 59.10% and beyond the yarn shrinks to a considerably less extent at the temperatures higher than 40°C. It is quite likely that the chemical attack of these concentrated solutions is much stronger at the higher temperatures which impedes the shrinkage and weakens the structural forces which hold the fibres in tact ultimately dissolving the yarn.

In solutions of phosphoric acid as well the percentage shrinkage of yarn increases with the concentration, reaches the maximum and then decreases at all the temperatures. It has been found that the yarn shrinks more at 40°C and 50°C than at 25°C in all the concentrations but at temperatures higher than 50°C the yarn shows less shrinkage with the rise in temperature (vide table IV). Apparently the chemical attack at the temperatures higher than 50°C is stronger and lessens the shrinkage of yarn. The period to attain the maximum shrinkage however, gets shorter with the increase in temperature.

It is interesting to note that the shrinkage of yarn increases with the rise in temperature in all the concentrations of the two salts viz. zinc chloride and calcium thiocyanate. It is well known that the changes in length of yarn as a consequence of mercerisation is the resultant of changes both in length and section of the cotton hairs and is complicated by the slipping, rearrangement and accommodation of the hairs in the yarn. Thus the change in the original structure of the yarn as a result of the attack of the swelling agents constitutes one of the major factors causing difference in shrinkage. It is quite likely that this attack on the structural forces which hold the yarn together should increase in severity with the rise in temperature in the case of acid solutions where as in the case of salt solutions this attack is not so severe

so as to retard the swelling of cellulose. These observations are substantiated by the facts that in the case of salt solutions the best mercerising effects are obtained at higher temperatures unlike the solutions of caustic soda where lower temperatures give better results. It has been found by Mercer and others that the solutions of salts like zinc-chloride, calcium thiocyanate, etc. become more effective in concentrated solutions and, unlike the cases of caustic soda and sulphuric acid, at higher temperature.

The action of the swelling agents varies considerably with the strength, temperature and time of reaction. For example, the effect produced by sulphuric acid on the yarn or cloth differs remarkably with difference in temperature and hence it has got to be used very carefully in the proper concentration at the proper temperature according to the effect desired such as parchmentisation of cloth and paper, mercerisation, increase in the affinity for dye stuffs, etc.

It may thus be seen that the temperature has got a considerable effect on the process of shrinkage of yarn in the solutions of zinc-chloride, calcium thiocyanate, sulphuric acid and phosphoric acid. The results contained in this paper, covering a wide range of concentration and temperature with regard to the swelling agents mentioned above, which are of importance to the textile industry, it is believed, will be of considerable value in the technical applications of these reagents.

ACKNOWLEDGEMENT

Our thanks are due to Dr. G. S. Kasbekar M. Sc. (Bom.) Ph. D. (Manch.) for suggesting the line of work and Prof. D. Fraser and Prof. P. M. Barve of the Wilson College, Bombay for the valuable help during the course of this investigation.

REFERENCE

- (1) G. S. Kasbekar and S. M. Neale; Trans. Far. Soc. Aug.-Sept. '47, p. 517.

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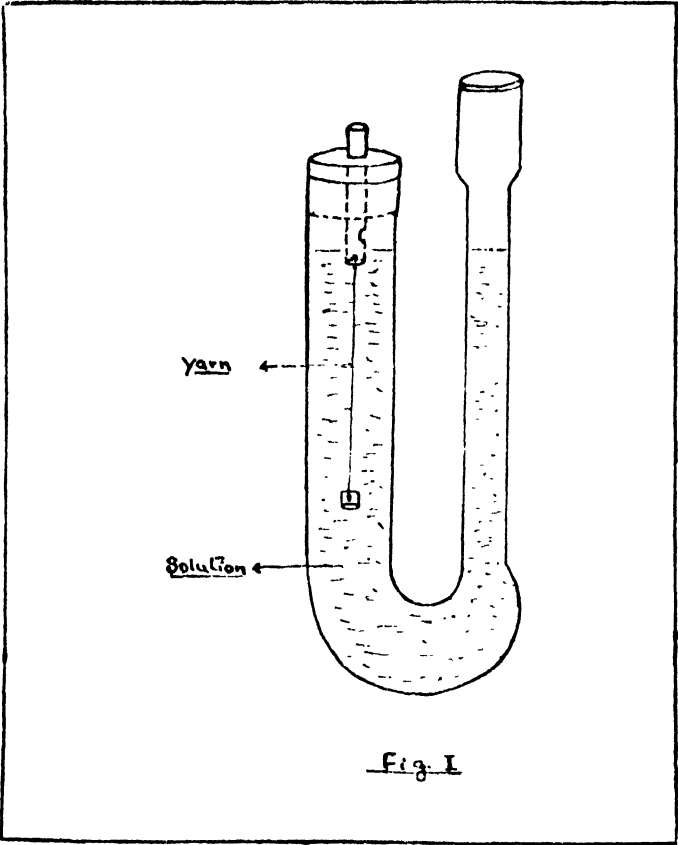
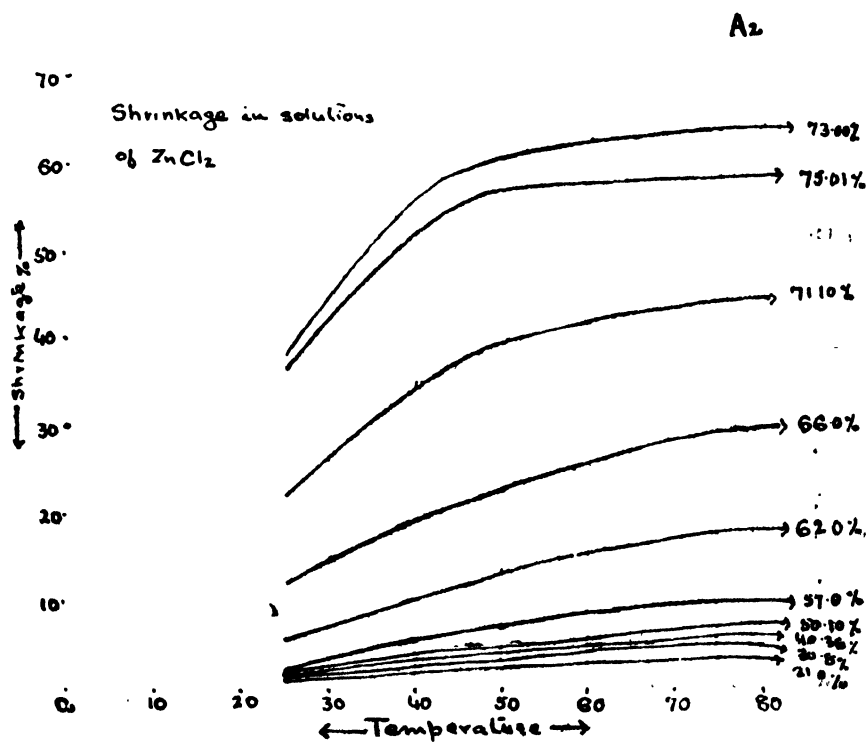
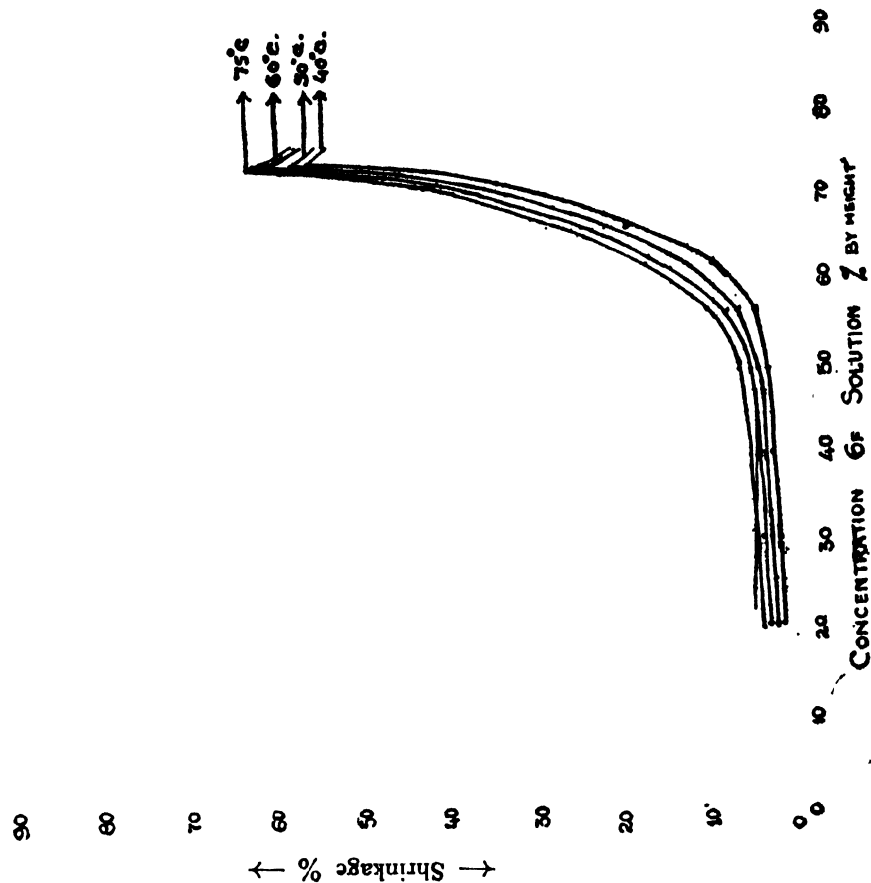
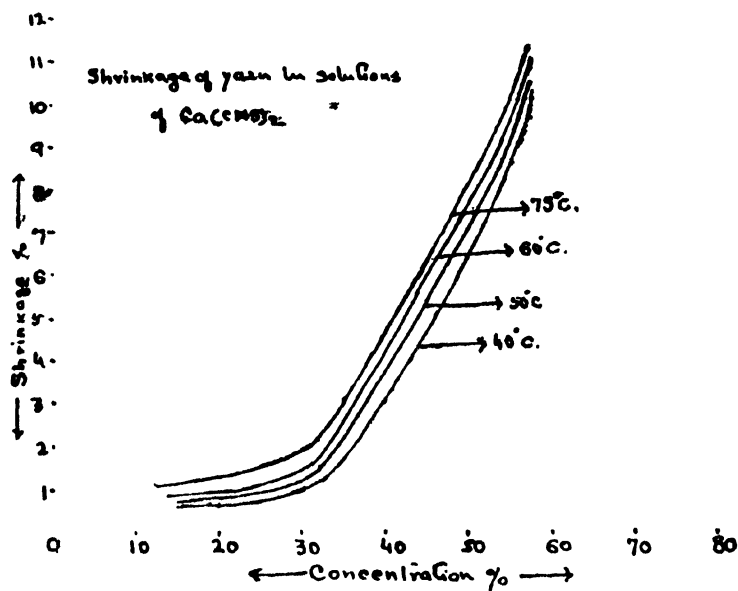
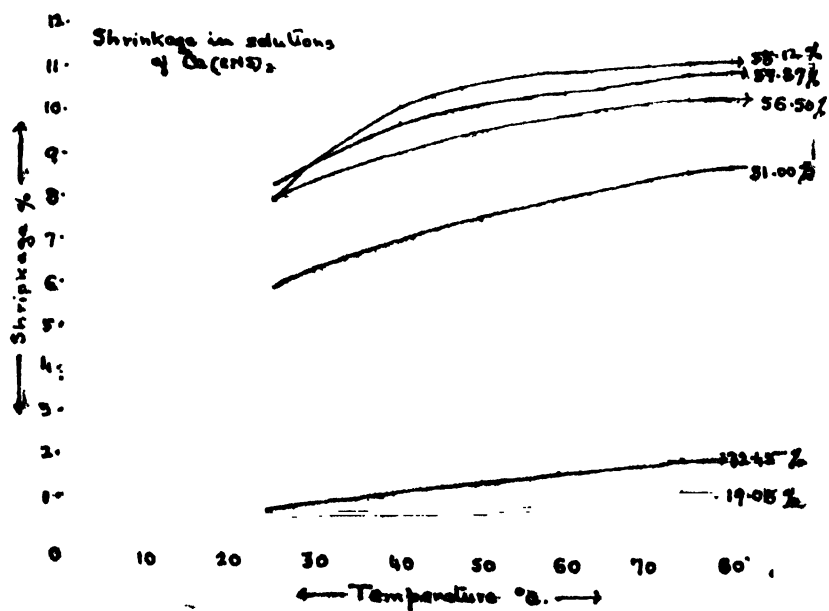
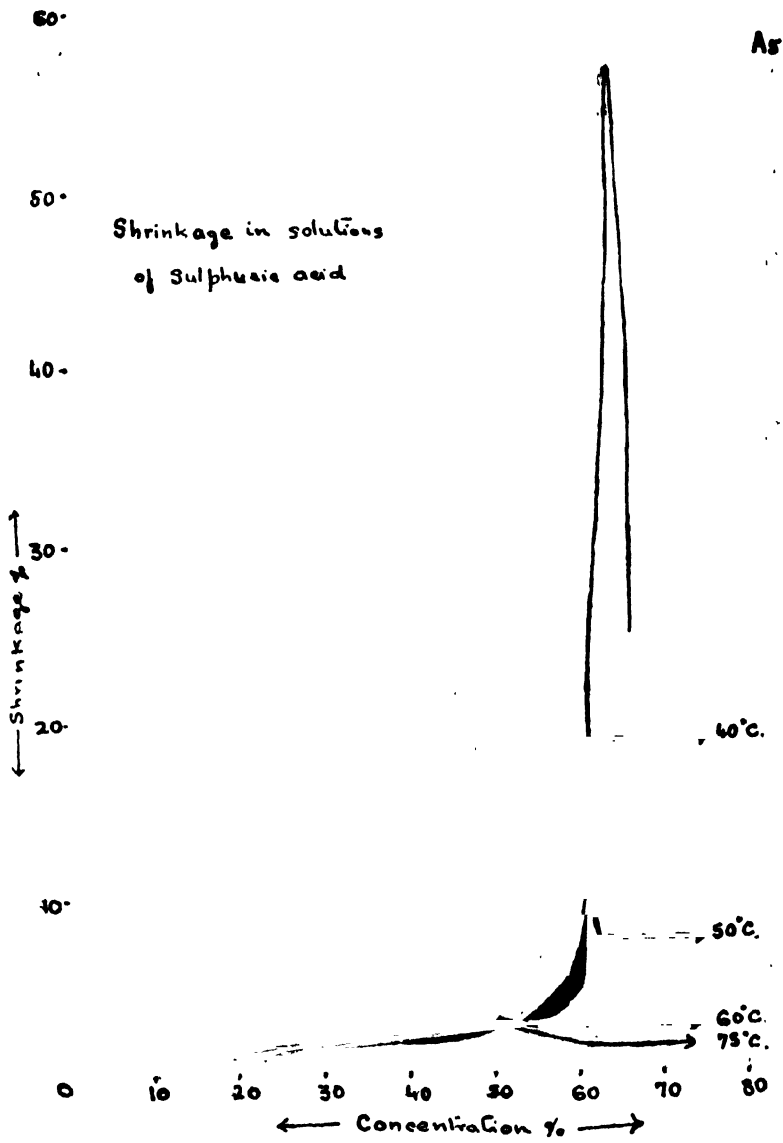
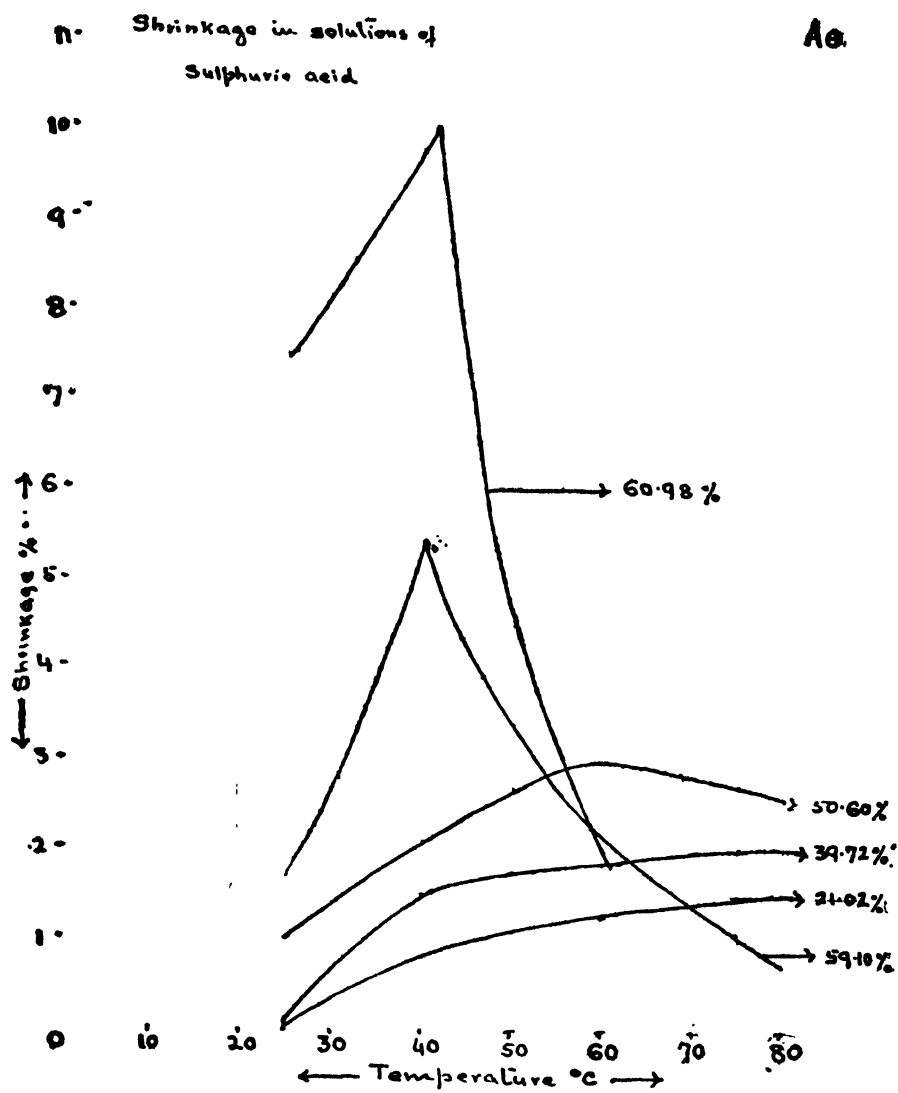


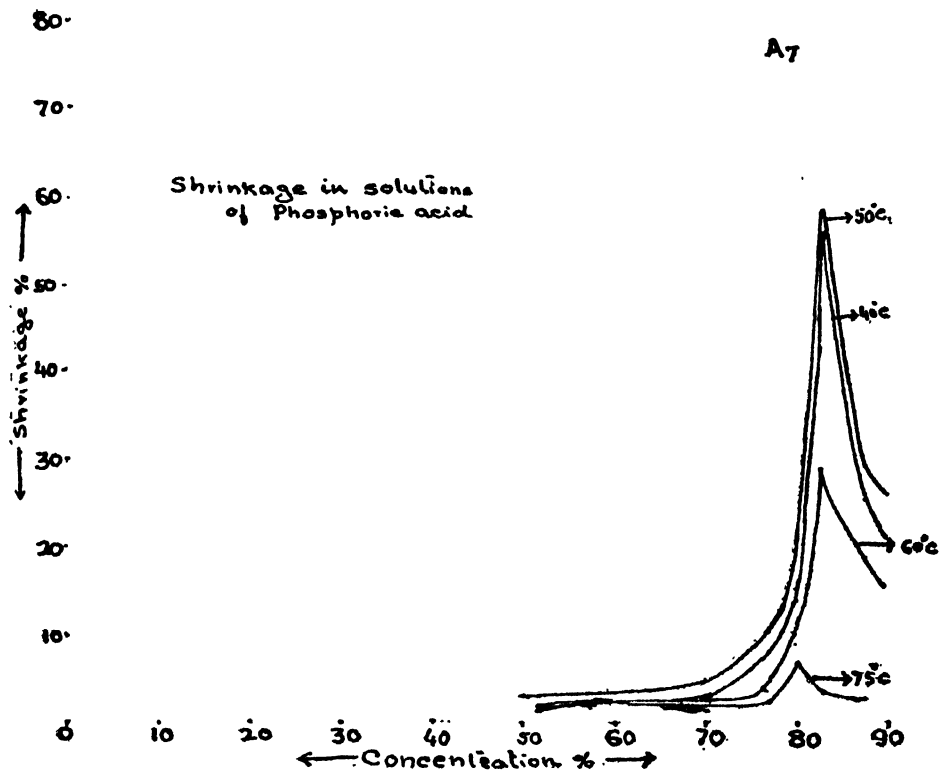
TABLE 1
SHRINKAGE OF YARN IN SOLUTIONS OF ZINC-CHLORIDE.

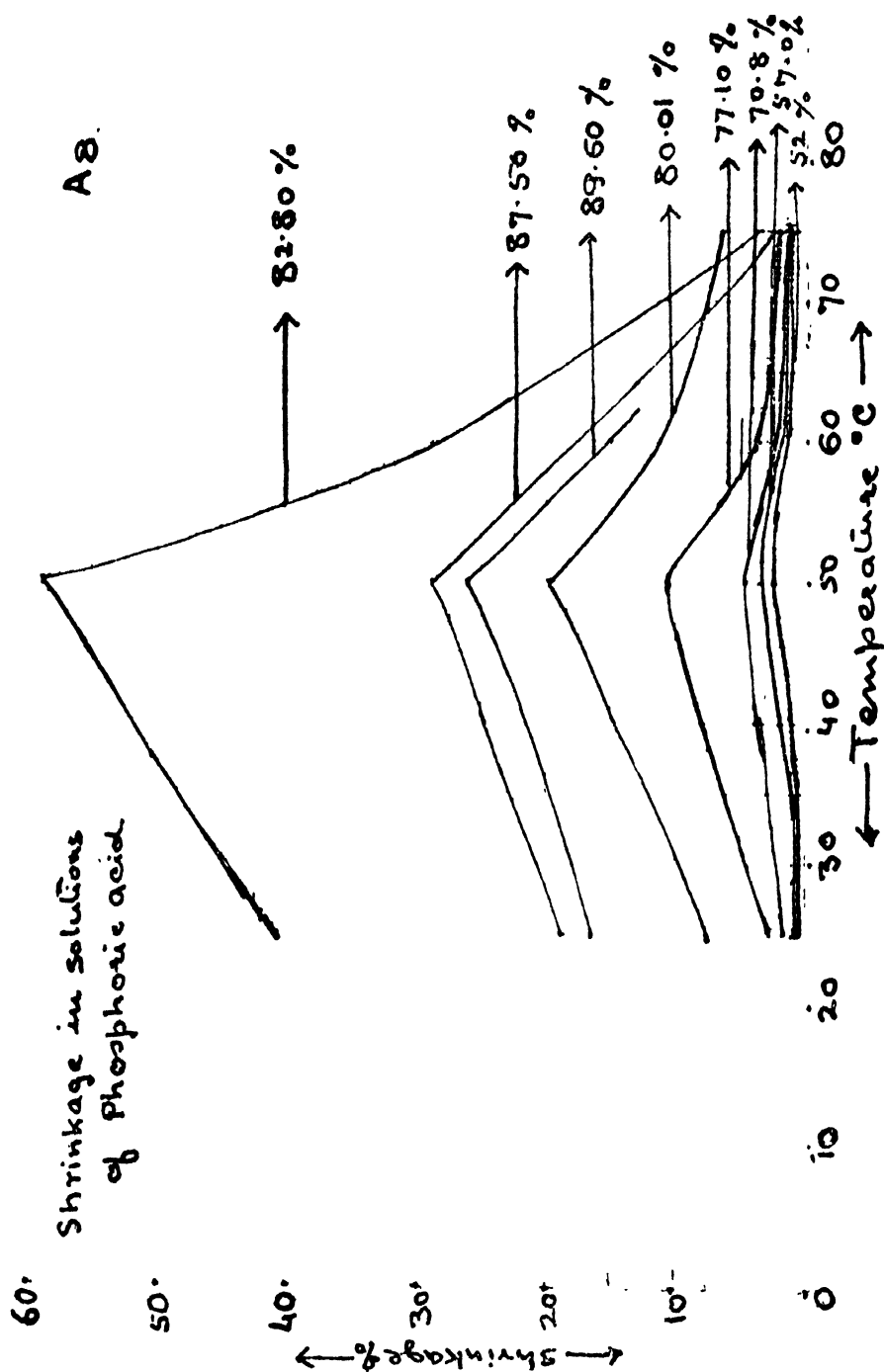


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CONDENSATION OF ACETONE-DI-CARBOXYLIC ACID WITH β -NAPHTHYL METHYL ETHER

Isolation of β -(-2 methoxy naphthyl-3-)-glutaconic acid in 'Cis' and 'Tran' modifications

BY R. V. BHAGWAT AND V. M. BHAVE

A short abstract :—

Contrary to the observation of a previous worker, β -Naphthyl methyl ether has been found to condense directly with Acetone-di-carboxylic acid giving well defined 'Cis' and 'Trans' modifications of β -(-2 methoxy naphthyl-3-)-glutaconic acid, which had so far to be prepared indirectly.

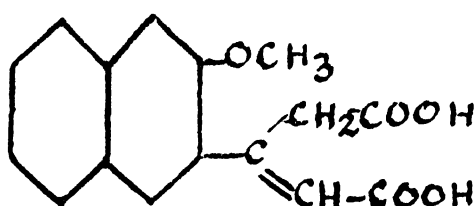
THE alkyl substituted glutaconic acids have been found to exist in two well defined 'Cis' and 'Trans' modifications by previous workers, especially by Thorpe and others (Perkin and Tattersall, J. C. S. T. 1905, 87 361 ; Thorpe and Bland J. C. S. T. 1912, 101, 856 ; Thorpe and Wood J. C. S. T. 1913, 103, 1569 etc.). Because of the difficulty of obtaining the β -aryl substituted glutaconic acids, only one acid, namely the β -phenyl glutaconic acid was studied by them extensively. It was found that this acid could be isolated in the 'Cis' modification only (Thorpe and Wood, loc. cit.).

Since then, following the method of Limaye and Bhawe (J. I. C. S. 1931, 8, 137) a number of β -aryl glutaconic acids have been prepared by the condensation of Acetone-di-carboxylic acid with Phenolic ethers (Limaye and Gogte J. Uni. Bom. 1934, III, 135 ; Gogte, Proc. Ind. Acad. Sc. 1934, I, 48-59 ; Bhawe and Limaye, Rasayanam, 1939, III, 6, 180 ; Bhawe, Ph. D. Thesis, Uni. Bom. 1942). But in every case the acids have been reported only in the 'Cis' form. Gogte (Proc. Ind. Acad. Sc. 1934, I A, 53) tried to condense the β -Naphthyl methyl ether with Acetone-di-carboxylic acid, but was unable to obtain any product of condensation. By following a method of simultaneous hydrolysis and methylation of the coumarin ring (Compare also Limaye, Proc. Ind. Sc. Congress, 1932, Abst. No. 149, p. 226) of an acid which Dey refers to as "4:3 β -naphtha pyrone-1-acetic acid" (J. C. S. 1915, 107, 1627) and which Gogte considers to be " β -naphtha coumarin-4-acetic acid" ; Gogte (loc. cit.) was able to prepare β -(2 methoxy naphthyl-3-)-glutaconic acid and obtained it in 'Cis' and 'Trans' forms.

The present authors, while attempting the condensation of β -naphthyl methyl ether with acetone-di-carboxylic acid, found that contrary to the observation of Gogte (loc. cit.), a direct condensation

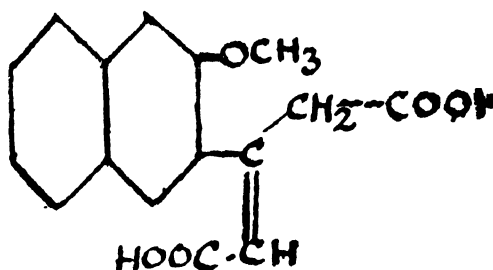
between these substances could be brought about under controlled conditions of temperature. But in place of the expected 'Cis' form only of a β -(β -naphthyl substituted)-glutaconic acid, two isomeric acids were isolated. It was later on found that these two acids were identical with similar two isomeric acids prepared by Gogte by an indirect method (Gogte, loc. cit.), from an acid, which he describes as " β -naphthacoumarin-4-acetic acid." The identity of these two acids with those prepared by Gogte was confirmed by taking their mixed melting points. Therefore, provisionally accepting the structures assigned to these acids by Gogte, the two acids may be described as 'Cis' and 'Trans' forms of β -(2-methoxy-naphthyl-3)-glutaconic acid. The 'Cis' and 'Trans' forms of the acid were found to be accompanied by the β -naphthacoumarin-4-acetic acid, which appears to result from the condensation of β -naphthyl methyl ether with Acetone-di-carboxylic acid, followed by demethylation and loss of a molecule of water i. e. coumarin formation.

The two acids obtained in the present case have been represented as follows :—



Acid M. P. 162°

'Cis' form



Acid M. P. 185°

'Trans' form

of

" β -(2-methoxy-naphthyl-3)-glutaconic acid".

EXPERIMENTAL

Condensation of Acetone-di-carboxylic acid with β -naphthyl methyl ether :—

Acetone-di-carboxylic acid mixture was prepared from 25 gms of citric acid and 40 ccs of pure conc. H_2SO_4 (Dey and Row, J. Ind. Chem. Soc. 1924, 1, 112) in a flask fitted with a mechanical stirrer. The powdered β -naphthyl methyl ether (5 gms) was slowly added in small portions at a time. The flask was kept in an ice bath at 0°C for 6 hours and then left overnight at room temperature. After about 24 hours, the reaction mixture was poured on crushed ice (200 gms) and filtered after one hour. The residue was washed with water and rubbed in a mortar with NaHCO_3 solution in which the unreacted β -naphthyl methyl ether remained insoluble, while the other portion dissolved with effervescence of CO_2 . The alkaline filtrate was acidified with dilute HCl , the yellow mass obtained being washed with water and dried. (1 gm).

The β -naphtha coumarin-4-acetic acid :—

The yellow reaction product (5 gms) obtained as above was boiled with 250 ccs of 5% aqueous acetic acid solution and filtered hot. The residue (A) obtained was purified and confirmed to be the β -naphtha-coumarin-4-acetic acid M. P. 200° , described by B. B. Dey (J. Chem. Soc. 1915, 107, 1615). The identity was confirmed by taking mixed melting point of this acid with that prepared by Dey's method (ibid), which showed no depression.

The product which was obtained on cooling the acetic acid filtrate, was also a mixture and by fractional crystallisation from 20% methyl alcohol solution, it could be separated into two acids : (i) The acid (B) M. P. 162° and (ii) the acid (C) M. P. 185° .

The 'Cis' form M. P. 162° (decomp.) of the β -(2 methoxy-naphthyl-3-) glutaconic acid :—

This was more soluble in 20% methyl alcohol solution and was crystallised from water. It was insoluble in benzene and did not give any colouration with FeCl_3 solution. (Equivalent found 142.4 ; dibasic acid $\text{C}_{16}\text{H}_{14}\text{O}_5$ requires 143. Analysis :— Found C : 66.97%, H : 4.78% ; $\text{C}_{16}\text{H}_{14}\text{O}_5$ requires C : 67.13%, H : 4.89%).

This acid M. P. 162° did not depress the melting point of the acid M. P. 162° prepared by Gogte's method (Proc. Ind. Acad. Sc. 1934, IA, 48-59).

The anhydride of β -(2 methoxy naphthyl-3-) glutaconic acid :—

When the acid (B) M. P. 162° was heated above its melting point or when it was heated with acetic anhydride (2 gms of the acid with 4 ccs of acetic anhydride), the anhydride M. P. 134° , $\text{C}_{16}\text{H}_{12}\text{O}_4$ was obtained. It was soluble in benzene and gave a reddish colouration with FeCl_3 solution. It could be titrated with decinormal alkalies (Equivalent found : 265.6 ; monobasic acid $\text{C}_{16}\text{H}_{12}\text{O}_4$ requires 268. Analysis ; Found C : 71.44%, H : 4.45% ; $\text{C}_{16}\text{H}_{12}\text{O}_4$ requires C : 71.64%, H : 4.47%).

The 'Trans' form M. P. 185° of the β -(2 methoxy naphthyl-3-) glutaconic acid :—

This acid (C) M. P. 185° was more insoluble in 20% methyl alcohol. It was insoluble in benzene and did not give any colouration with FeCl_3 . It remained unaffected when heated with acetic anhydride. When heated above its melting point, it decomposed, and from the products of decomposition, the anhydride M. P. 134° identical with the anhydride mentioned above could be isolated. (Equivalent :— Found 142.4 ; dibasis acid $\text{C}_{16}\text{H}_{14}\text{O}_5$ requires 143: Analysis : Found C : 66.91%, H : 4.96%, $\text{C}_{16}\text{H}_{14}\text{O}_5$ requires C : 67.13%, H : 4.89%).

The β -(2-methoxy naphthyl-3)-glutaconyl acetic acid M. P. 173° :—

This was prepared from the acid (B) M. P. 162° by the method of Bhawe and Limaye (J. Uni. Bom. Sept. 1933, p. 82). The acid M. P. 162° (5 gms) was powdered and well mixed with an equal quantity of fused sodium acetate in a mortar. Acetic anhydride (7.5 ccs) was added and the flask heated in a boiling water bath for 8-9 minutes. The dark orange mixture was poured in about 100 ccs of water with good stirring. After 15 minutes, 7.5 ccs of Conc. HCl were added and the pink mass obtained was washed with water and dried. It was soluble in benzene and ethyl alcohol and gave a deep violet colouration with FeCl_3 . (Equivalent found 313.3; monobasic acid $\text{C}_{18}\text{H}_{14}\text{O}_5$ requires 310. Analysis: Found C: 69.97%, H: 4.40%; $\text{C}_{18}\text{H}_{14}\text{O}_5$ requires C: 69.68%, H: 4.51%.

It may be mentioned here that when the acid (C) M. P. 185° was subjected to a similar action of fused sodium acetate and acetic anhydride, a high melting compound (M. P. 254-56°) was obtained, which could not be purified by crystallisation and was therefore kept aside for further investigation.

The methyl acid ester M.P. 126° of the β -(2-methoxy-naphthyl-3)-glutaconic acid was prepared by heating under reflux for five hours 1.0 gm of the anhydride M.P. 134° with 5 ccs of dry methyl alcohol. The excess of alcohol was removed by heating on water bath and the residue was dissolved in ether. The ethereal solution was treated with Na_2CO_3 solution. On acidifying the alkaline extract with dilute HCl, a white product separated which solidified on keeping overnight. It was crystallised from water in colourless crystals. M.P. 126°. (Equivalent: Found 300.7; monobasic acid $\text{C}_{17}\text{H}_{16}\text{O}_5$ requires 300.)

The ethyl acid ester M.P. 115° of β -(2-methoxy naphthyl-3)-glutaconic acid was prepared in a similar way to the above ester by using 1 gm of the anhydride M.P. 134° and 5 ccs of absolute ethyl alcohol. It could be crystallised from water. (Equivalent: Found 311.5; monobasic acid $\text{C}_{18}\text{H}_{18}\text{O}_5$ requires 314).

It may be mentioned here that ' β -naphthyl ethyl ether', also, has been found to condense with Acetone-di-carboxylic acid, a description of which is reserved for further communication.

The authors take this opportunity to express their thanks to the authorities of Ramnarain Ruia College, Bombay, for giving them facilities to carry out the above work.

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A STUDY OF THE OIL FROM THE SEEDS OF

Mesua Ferrea (N. O.: *Guttiferæ*)

BY K. D. PHADNIS, A. V. REGE, D. G. PISHAVIKAR AND S. V. SHAH

THE oil obtained from the seeds of '*Mesua Ferrea*' has been worked out by various workers taking many samples from different parts of India, particularly from the Himalayan region (Hooper, Ann. Rep. Indian Museum, 1907-08, 13; Mukarjee, Proc. Inst. Chem. India, Vol.V, Part II, 80). It is said that the irregular results obtained by various workers are, due to varying amount of resinous matter present in the oil. Dhinghra and Hilditch, (J. Soc. Chem. Ind., Vol. L, 9-T) examined the oil obtained from the seeds found round about Malabar and Assam. It is also very interesting to note that their values differ from those obtained by us.

For the present investigation, we have selected the seeds of '*Mesua Ferrea*' from Western Ghats. The trees are also found to grow round-about Kolhapur.

The fruit contains an oleo-resin from which an essential oil is obtained. The seeds contain a fixed oil. The hard pericarp contains tannin. The decorticated seeds were extracted with petroleum ether in a soxhlet when a dark red coloured oil was obtained. The yield is above 60 percent calculated on the kernels. The last traces of the solvent were removed by distillation under vacuum and the oil thus obtained gave the following values:

TABLE NO. I

Specific gravity at 27°C ..	0.9265	Refractive Index at 27°C	1.4775
Saponification value ..	205.0	Iodine value ..	92.70
Acid value ..	31.27	Acetyl value ..	12.41
R. M. Value ..	5.067	Polenske Number ..	0.878
<hr/>			
Unsaponifiable matter ..	..	..	0.800 per cent
Yield ..	..	..	65.80 per cent

The Insoluble Fatty Acids :

The oil was saponified by means of alcoholic—potassium hydroxide and the soaps were dissolved in a large quantity of water. The unsaponifiable matter was extracted with ether and the free acids liberated were taken up in ether and the ether extract was washed free from hydrochloric acid. The ether solution was then dried over anhydrous sodium sulphate, and filtered. The ether was distilled off and the mixed fatty acids thus collected were further dried over calcium chloride in vacuum desiccator. The mixed fatty acids gave the following values:

TABLE NO. II
Mixed Fatty acids

Yield	94.56 per cent
Titre value	33.34°C
Iodine Value	96.80
The neutralisation value	209.37
The Mean Molecular weight	273.30

Separation of the Fatty Acids:

The mixed acids were separated into liquid (unsaturated) and solid (saturated) fatty acids by the precipitation of the fatty solid acids with lead acetate in alcoholic solution by Twitchell's method (J. Ind. Eng. Chem., 13, 806).

TABLE NO. III
Separation of the Fatty Acids

Mixed acids taken	40.00 gms.
Total liquid acids obtained	32.64 gms.
Total Solid acids obtained	7.360 gms.
Melting point of the solid acids	56°C
Iodine value „ „ „ „	1.88
Acid Number „ „ „ „	204.45
Molecular weight „ „ „ „	273.95
Thus, Total solid Acids	18.40 per cent
Total Liquid Acids	81.60 per cent

The solid (saturated) acids as obtained above were then turned into their methyl esters by refluxing the acids with methyl alcohol saturated with dry hydrogen chloride gas. 24.00 gms. of these esters were then distilled under reduced pressure of 2.8 mm. and the following fractions were obtained.

TABLE NO. IV

Fraction	Temperature °C	Weight	S.V.	Mean Mol. Wt.
1	upto 180	4.7846 gms.	202.8	276.8
2	180-185	6.3486 gms.	197.3	284.1
3	185-189	4.2734 gms.	196.4	285.5
4	189-194	4.1530 gms.	194.6	288.2
5	194 onwards	2.8210 gms.	191.5	293.2
6	Residue	1.2250 gms.	.....	.....
Total Weight ..		23.6056 gms.		

Each of these fractions of the methyl esters was hydrolysed separately with potassium hydroxide and the corresponding fractions of the fatty acids were obtained by acidifying the soaps with hydrochloric acid. Mean molecular weights and the melting points of the different fractions (corresponding to the fractions of the methyl esters in Table No. IV) are given in the following Table:

TABLE No. V

Fraction	M.P. °C	Wt. of Acids (corresponding to the esters : Table IV)	Acid Number	Mean Mol. Wt.	Per- centage Palm- itic Acid	Stearic Acid
1	56	4.560 gms.	212.8	263.4	73.57	26.43
2	56	6.100 gms.	207.15	270.7	47.50	52.50
3	57	4.100 gms.	206.10	272.1	42.50	57.50
4	58	4.000 gms.	204.82	274.6	33.57	66.43
5	62	2.700 gms.	200.5	279.7	15.36	84.64
6	69	1.200 gms.	197.9	283.1	3.21	96.79
Total :		22.6600 gms.				

The free acids thus obtained from the methyl esters were further separated into individual acids by fractional crystallisation of the acids from methyl alcohol. From fractions (II, III, IV) palmitic and stearic acids were obtained by precipitating them fractionally by magnesium-salt-method ; and recrystallisation of the acids liberated from the salts.

From the above tables the approximate percentages of the individual acids in the solid fraction were calculated.

Stearic acid	..	56.79 per cent	} Constituting 18.40 per cent of the total fatty acids.
Palmitic acid	..	43.21 per cent	

Unsaturated (Liquid) Acids :

After the removal of the solid acids as insoluble lead salts of the saturated acids, the liquid acids were liberated with dilute hydrochloric acid from their lead salts and extracted with ether. They were washed and then dried over anhydrous sodium sulphate. The acids thus obtained gave the following values :

TABLE VI
Unsaturated (Liquid) Fatty Acids

Iodine Value	..	..	116.8	Acid Number	..	197.6
Mean Molecular weight	..	..	..	..	..	283.30

Bromination of Liquid Fatty Acids :

A weighted quantity of liquid acids was dissolved in ether and kept in ice. A cold solution of bromine was added gradually to the solution of the acids with constant shaking. The reaction mixture was left overnight in an ice box. Next day no white solid compound was obtained. This showed the absence of hexabromide. The excess of bromine was washed with water and then dilute solution of sodium thiosulphate and finally again with water. It was then mixed with petroleum ether and rubbed, when a white solid compound was separated. It was filtered and washed with petroleum ether and dried. It was recrystallised from alcohol.

Yield	..	..	5.8 gms.	(From 10.4 gms. of liquid acids)
M.P.	..	..	114° C.	Bromine (Found) .. 53.45 per cent
				Bromine (required) .. 53.33 per cent
				(C ₁₈ H ₃₂ O ₂ Br ₄)

From the filtrate and the washings ether was removed when a liquid compound was obtained.

Yield	..	12.10 gms.	Bromine (Found)	..	..	36.97 per cent
			C ₁₈ H ₃₄ O ₂ Br ₂ required	..	..	36.20 per cent

The tetrabromide (5.8 gms.) corresponds to 2.69 gms. of linolic acid. The dibromide (12.10 gms.) corresponds to 7.66 gms. of oleic acid.

Thus 10.4 gms. of the liquid fatty acids gave on bromination

5.80 gms. of tetrabromo-stearic acid.
12.1 gms. of dibromo-stearic acid.

17.90 gms. Total bromo acids.

Hence the composition of the unsaturated acids :

Linolic acid	..	..	..	25.80 per cent
Oleic acid	..	..	..	74.20 per cent
(Constituting 81.60 per cent of the total fatty acids)				

Summing up, the total insoluble fatty acids in the oil are :

Solid (saturated) acids	Stearic acid	..	10.45 per cent
18.40 per cent	Palmitic acid	..	7.95 per cent
Liquid (unsaturated) acids	Linolic acid	..	21.05 per cent
81.60 per cent	Oleic acid	..	60.55 per cent

Unsaponifiable Matter :

The unsaponifiable matter was obtained from the etherial washings of the dry soaps after they were washed with water to remove any dissolved soaps. A white solid on crystallisation from alcohol melted at 130-132° C.

(Our thanks are due to Mr. Kashalkar for doing some preliminary work).

One of us (S.V.S.) thanks the University of Bombay for a research grant in this connection.

SYNTHETIC ANTHELMINTICS

Part XVII—Synthesis of Lactones analogous to Angelica Lactones (γ Substituted phenyl Δ^b crotono lactones)

BY V. K. PARANJPE, THE LATE N. L. PHALNIKAR AND B. V. BHIDE

THIS communication is in continuation of the work of Shah and Phalnikar (J. Univ. Bom. XIII, iii, 22 (1944)). 2 alkoxy tolyl Δ^b crotono lactones and 2 : 5 dialkoxy phenyl Δ^b crotono lactones have been prepared and their toxicity towards earth-worm has been studied.

The lactones described in this work are prepared by the action of acetic anhydride on the corresponding substituted benzoyl propionic acids. The acids were kindly supplied by Dr. Nargund of Gujarat College, Ahmedabad.

All the lactones are insoluble in cold sodium bicarbonate. They do not give any colouration with ferric chloride. They are, unlike angelica lactones, more stable and are high melting, crystalline solids. The lactone group however, could not be estimated by boiling with barium hydroxide. The constitution of the lactones has been confirmed by hydrolysing them with alkali to the corresponding keto acids.

Some of the above lactones have been characterised by preparing their aryldine derivatives, by treating the lactone with the aromatic aldehyde in the presence of pyridine. The derivatives thus obtained are highly coloured crystalline high melting substances and have been described in table II.

The experiments on toxicity to earth-worms—following the simple immersion method of Sollmann (J. Pharma. and Exp. Therap., 12, 129 (1919))—show that the phenyl crotono lactones in general are not toxic to worms and hence probably are of very little value as anthelmintics. The unsaturation in the lactone ring does not seem to have improved the anthelmintic property. This supports the observation of Shah and Phalnikar (loc. cit.)

TABLE NO. I

No.	Lactones	Formula	Description	Found		Required	
				C%	H%	C%	H%
1	γ -5 methyl 2-ethoxy phenyl Δ^b crotono lactone.	$C_{13}H_{14}O_3$	By the action of acetic anhydride on 5 methyl 2 ethoxy benzoyl propionic acid. Red needles from dilute acetic acid. m.p. 120° C.	71.17	6.22	71.55	6.42
2	γ -5 methyl 2-propoxy phenyl Δ^b crotono lactone.	$C_{14}H_{16}O_3$	From 5 methyl 2-propoxy benzoyl propionic acid. Shining violet crystals from dil. acetic acid. m.p. 165° C.	72.38	6.95	72.41	6.89
3	γ -5 methyl 2-n-butoxy phenyl Δ^b crotono lactone.	$C_{15}H_{18}O_3$	From 5 methyl 2-n-butoxy benzoyl propionic acid. Violet needles from acetic acid. m.p. 223° C.	73.2	7.08	73.18	7.32
4	γ -5 methyl 2-isobutoxy phenyl Δ^b crotono lactone.	$C_{15}H_{18}O_3$	From 5 methyl 2-isobutoxy benzoyl propionic acid. Shining crystals from acetic acid m.p. 232° C.	73.2	7.18	73.18	7.32
5	γ -5 methyl 2-isoamyloxy phenyl Δ^b crotono lactone.	$C_{16}H_{20}O_3$	From 5 methyl 2-isoamyloxy benzoyl propionic acid. Shining violet needles from acetic acid. m.p. 256° C.	73.28	7.4	73.84	7.69
6	γ 2:5 diethoxy phenyl Δ^b crotono lactone.	$C_{14}H_{16}O_4$	From 2:5 diethoxy benzoyl propionic acid. Violet crystals from acetic acid. m.p. 161° C.	67.17	6.5	67.74	6.45
7	γ 2:5 dipropoxy phenyl Δ^b crotono lactone.	$C_{16}H_{20}O_4$	From 2:5 dipropoxy benzoyl propionic acid. Shining plates from acetic acid. m.p. 235° C.	69.3	7.2	69.56	7.25
8	γ 2:5 di-n-butoxy phenyl Δ^b crotono lactone.	$C_{18}H_{24}O_4$	From 2:5 di-n-butoxy benzoyl propionic acid. Shining needles from dil. acetic acid. m.p. 225° C.	70.98	7.55	71.06	7.89

TABLE NO. II

No.	Arylidine derivative	Formula	Description	Found		Required	
				C%	H%	C%	H%
1	α benzylidene 5 methyl 2-ethoxyphenyl crotono lactone.	$C_{20}H_{18}O_3$	From benzaldehyde and 5 methyl 2-ethoxyphenyl crotonolactone. Crystallised from acetic acid in shining brick red crystals m.p. 161°C.	78.25	5.55	78.43	5.88
2	α 4 hydroxy 3 methoxy benzylidene 5-methyl 2-ethoxyphenyl crotono lactone.	$C_{21}H_{20}O_5$	From Vanillin and 5 methyl 2 ethoxy phenyl crotono lactone. Brown crystals from acetic acid m.p. 203°C.	71.3	5.75	71.65	5.68
3	α 2 hydroxy benzylidene 5-methyl 2 ethoxy phenyl crotono lactone.	$C_{20}H_{18}O_4$	From salicylaldehyde and 5 methyl 2 ethoxy phenyl crotono lactone. Dark brown crystals from acetic acid. m.p. 221°C.	74.2	5.94	74.52	5.59
4	α p-hydroxy-benzylidene 5-methyl 2-ethoxy phenyl crotono lactone.	$C_{20}H_{18}O_4$	From p-hydroxybenzaldehyde and 5 methyl 2-ethoxy phenyl crotono lactone. m.p. 237°C. Yellow needles from acetic acid.	74.18	5.7	74.5	5.59
5	α p-hydroxy-benzylidene 5-methyl 2 propoxy phenyl crotono lactone.	$C_{21}H_{20}O_4$	From p-hydroxy benzaldehyde and 5 methyl 2-propoxy phenyl crotono lactone. Dark brown crystals from acetic acid. m.p. 198°C.	74.65	5.94	74.66	5.92
6	α 2-hydroxybenzylidene 5-methyl 2-n-butoxy phenyl crotono lactone.	$C_{22}H_{22}O_4$	From salicylaldehyde and 5 methyl 2-n-butoxy phenyl crotono lactone. Brown yellow needles from acetic acid. m.p. 169°C.	75.44	6.37	75.43	6.28
7	α 4 hydroxy 3-methoxy -5-methyl 2-n-butoxyphenyl crotono lactone.	$C_{22}H_{24}O_5$	From Vanillin and 5-methyl 2-n butoxy phenyl crotono lactone. Yellow crystals from acetic acid.	72.61	6.35	72.64	6.31

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AZO DYES FROM SULPHA DRUGS

By T. R. INGLE, N. V. BRINGI,
THE LATE N. L. PHALNIKAR AND B. V. BHIDE

GLEY and Girard (Presse. Med. 44, 1775, (1936)) have shown that a substituent in azo dyes from sulphanilamide is of significance in their antibacterial action. Goissedel et al. (Compt. Rend. Soc. Biol. 121, 1082, (1936)) showed that the azo dye from resorcinol and sulphanilamide has good antibacterial activity. More recently several other workers have shown that these azo dyes reduce the toxicity of sulphanilamide. (Cf. Dainow, Biol. Abst. 14, 654, (1940); Dainow, Der Matologia 83, 43, (1941; Tarentelli, Athena 10, 80, (1941); Martin et al. J. Biol. Chem. 139, 871, (1941)).

Recently a few phenolic dyes have been prepared by Rajgopalan (Proc. Ind. Acad. Sci. 19A, 351, (1944)) and have been examined for their antibacterial properties. The present communication describes a number of such dyes derived from phenols and sulpha drugs.

It is well known that azo dyes exert their antibacterial action by breaking up *in vivo* into sulphanilamide and the other component. It was, therefore, thought that phenolic dyes might be found to be more effective due to the combined action of the phenol and the sulpha drug which might be liberated *in vivo*.

A list of several dyes prepared from phenols and the sulpha drugs is given in the experimental part. Dyes from No. 1 to No. 13, No. 24 to No. 26, and Nos. 31, 32 and 33 were examined for their antibacterial properties against: 1) E. Coli. 2) Staphylococcus Aureus. 3) B. Typhosus. 4) Boyd II. Almost all the dyes show enhanced activity over the parent sulpha drug.

In addition to this, all the dyes were tested against M. Tuberculosis (var. Hominis). It was found that dye from o-chlorophenol and sulphanilamide, dye from o-chlorophenol and sulphapyridine and the dye from o-iodophenol and sulphapyridine inhibit the growth of M. Tuberculosis in the concentration 1 in 1000, the rest of the dyes were ineffective.

EXPERIMENTAL

Preparation of Tri-bromo-resorcinol-mono-methyl-ether:—This was prepared by methylating tribromoresorcinol with the requisite quantity of dimethyl sulphate in alkaline solution. It crystallised from dilute ethyl alcohol in fan shaped needles. (M.P. 100°C. (Benedik Monatsh 1, 368, (1880)) prepared this compound by brominating mono-methyl-ether of resorcinol and reported M. P. 99°C).

Preparation of di-bromo-ethyl resorcinol:—This was obtained by brominating ethyl resorcinol in acetic acid. It crystallised from petroleum

ether (60-80) in fine needles. M. P. 67-68°C. Found Br, 54.2; $C_8H_8O_2Br_2$ requires Br, 54.02 per cent.

General method of the preparation of azo-dyes:—Sulphanilamide or its analogue (0.01 mol) and 1N hydrochloric acid (0.025 mol) and sufficient water to give a clear solution were cooled in ice. Sodium nitrite (0.0108 mol) was then added to it and the mixture was kept for 15 minutes below 15°C. This was filtered, and was added to the solution of phenol (0.01 mol) dissolved in the requisite quantity of 1N sodium hydroxide with vigorous stirring. The dye immediately separated. 5 gms. of sodium acetate was added to the mixture and then it was kept over-night. Next day it was filtered and the solid was dissolved in 10 per cent sodium hydroxide solution. The solution was filtered and the dye was reprecipitated by acidifying the filtrate. It was then dried and crystallised from a suitable solvent.

The following table summarises the dyes thus prepared.

TABLE 1

S.N.	Name	Formula	Description	Percentage of N.	
				Required	Found
1	Embellin and sulphanilamide	$C_{23}H_{31}O_6N_3S$	Reddish powder from ether and chloroform. Its colour changes at 171°C but did not decompose upto 300°C.	8.8	8.7
2	Embellin and sulphapyridine	$C_{28}H_{34}O_6N_4S$	Blackish powder from acetone. Colour changes from 205° to 300°C.	10.1	9.9
3	Embellin and sulphapyrimidine	$C_{27}H_{33}O_6N_5S$	Crystallised from acetone and petrol. M.P. 158-159°C.	12.6	12.5
4	Embellin and sulphathiazole	$C_{26}H_{32}O_6N_4S_2$	Crystallised from ethyl alcohol. Melts at 203°C with decomposition.	10.0	9.9
5	Sulphanilamide and o-chlorophenol	$C_{12}H_{10}O_3N_3SCl$	Red crystals from methyl alcohol. M.P. 243-44°C.	13.17	12.94
6	Sulphanilamide and o-bromophenol	$C_{12}H_{10}O_3N_3SBr$	It crystallises as yellow granular powder from methyl alcohol. It melts at 215°C, and decomposes at 220°C.	11.8	11.65
7	Sulphanilamide and o-Iodophenol	$C_{12}H_{10}O_3N_3SI$	Yellow crystals from methyl alcohol. It melts at 200°C, decomposes at 210°C.	10.4	10.3
8	Sulphanilamide and p-chlorophenol	$C_{12}H_{10}O_3N_3SCl$	Reddish plates from methyl alcohol. It melts with decomposition between 200-210°C.	13.17	12.8

S.N.	Name	Formula	Description	Percentage of N.	
				Required	Found
9	Sulphanilamide and p-bromophenol	$C_{12}H_{10}O_3N_3SBr$	Reddish powder from acetone. It melts at 210-212°C decomposes at 225°C.	11·8	11·7
10	Sulphanilamide and tribromophenol	$C_{12}H_8O_3N_3SBr_3$	It crystallises from methyl alcohol. It softens at 126°C, and decomposes at 250°C.	8·17	7·9
11	Sulphanilamide and tribromoresorcinol	$C_{12}H_8O_4N_3SBr_3$	Blackish powder from acetone. It does not melt upto 300°C.	7·9	8·0
12	Sulphanilamide and tribromoresorcinol mono methyl ether	$C_{13}H_{10}O_4SBr_3N_3$	Red crystals from methyl alcohol. It melts between 190-200°C and decomposes at 245°C.	7·7	7·8
13	Sulphanilamide and dibromoethyl resorcinol	$C_{14}H_{13}O_4N_3SBr_2$	Black powder from acetone. It decomposes at 275°C.	8·77	9·1
14	Sulphanilamide and o-propylphenol	$C_{15}H_{17}O_3N_3S$	Clusters of red needles from chloroform M. P. 212°C.	13·16	13·4
15	Sulphanilamide and o-n-butylphenol	$C_{16}H_{19}O_3N_3S$	Red needles from chloroform. M. P. 168°C.	12·6	12·7
16	Sulphanilamide and o-amylphenol	$C_{17}H_{21}O_3N_3S$	Red needles from chloroform. M. P. 178°C.	12·11	12·4
17	Sulphanilamide and p-ethylphenol	$C_{14}H_{15}O_3N_3S$	Red needles from benzene. M. P. 172°C.	13·77	14·0
18	Sulphanilamide and p-n-propylphenol	$C_{15}H_{17}O_3N_3S$	Crystallised from benzene. M. P. 189°C.	13·16	13·32
19	Sulphanilamide and p-n-butylphenol	$C_{16}H_{19}O_3N_3S$	Crystallised from acetone. M. P. 196°C.	12·6	12·7
20	Sulphanilamide and p-n-amylphenol	$C_{17}H_{21}O_3N_3S$	Reddish yellow needles from acetone. M. P. 175°C.	12·11	11·94
21	Sulphanilamide and p-n-hexylphenol	$C_{18}H_{23}O_3N_3S$	Crystallised from benzene. M. P. 170°C.	11·63	11·7
22	Sulphanilamide and p-heptylphenol	$C_{19}H_{25}O_3N_3S$	Red needles from benzene. M. P. 168°C.	11·2	11·37
23	Sulphanilamide and ethyl resorcinol	$C_{14}H_{15}O_4N_3S$	Crystallised from methyl alcohol. Melted between 180-185°C.	13·08	12·9

S.N.	Name	Formula	Description	Percentage of N.	
				Required	Found
24	Sulphathiazole and o-chlorophenol	$C_{15}H_{11}O_3N_4S_2Cl$	Yellow crystals from methyl alcohol. M. P. 234-235°C.	14.2	14.0
25	Sulphathiazole and p-chlorophenol	$C_{15}H_{11}O_3N_4S_2Cl$	Red plates from methyl alcohol. M. P. 190-200°C. with decomposition.	14.2	13.9
26	Sulphathiazole and p-bromophenol	$C_{15}H_{11}O_3N_4S_2Br$	Yellow plates from methyl alcohol. M. P. 190-200°C.	12.7	12.5
27	Sulphathiazole and ethyl resorcinol	$C_{17}H_{15}O_4N_4S_2$	Crystallised from acetone. M. P. 183°C.	13.76	14.3
28	Sulphathiazole and n-butyl resorcinol	$C_{19}H_{19}O_4N_4S_2$	Crystals from chloroform, M. P. 154°C.	13.3	13.18
29	Sulphathiazole and hexyl resorcinol	$C_{21}H_{23}O_4N_4S_2$	Swells at 220°C.	12.4	12.35
30	Sulphapyridine and ethylresorcinol	$C_{19}H_{17}O_4N_4S$	Crystals from methyl alcohol. M. P. 187°C.	14.07	14.18
31	Sulphapyridine and o-iodophenol	$C_{17}H_{13}O_3N_4SI$	Yellow crystals from acetone. M. P. 245°C.	11.67	11.4
32	Sulphapyridine and o-chlorophenol	$C_{17}H_{13}O_3N_4SCl$	Yellow powder from ethyl alcohol. Melts at 210-212°C. with decomposition.	14.42	14.4
33	Sulphapyrimidine and o-bromophenol	$C_{16}H_{12}O_3N_5SBr$	Yellow crystals from ethyl alcohol. M. P. 210°C.	16.11	16.0
34	Sulphapyrimidine and ethylresorcinol	$C_{18}H_{17}O_4N_5S$	Crystals from acetone M. P. 183°C.	17.54	17.12
35	Sulphapyrimidine and n-butylresorcinol	$C_{20}H_{21}O_4N_5S$	Crystals from chloroform M. P. 190°C.	16.4	16.53
36	Sulphapyrimidine and hexylresorcinol	$C_{22}H_{25}O_4N_5S$	Crystals from alcohol. M. P. 210°C.	15.38	14.8

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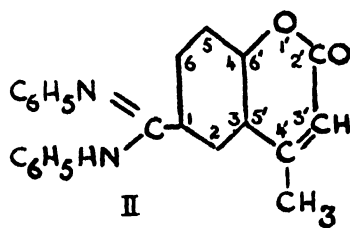
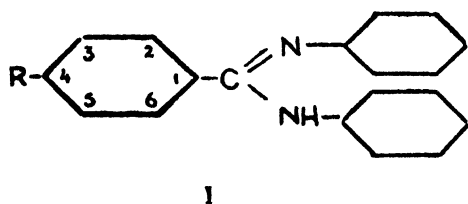
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SOME REACTIONS OF DIPHENYL *p*-AMINOBENZAMIDINE

BY K. R. BHARUCHA AND R. C. SHAH

ALTHOUGH diphenyl *p*-aminobenzamidine (I; R = NH₂) was first prepared by Hofmann (Proc. Roy. Soc., 1858, 9, 284) as early as 1858, yet as is revealed by literature, little work has been done on its reactions. As it is now readily available in good yield by the condensation of aniline with carbon tetrachloride in presence of a slight trace of copper bronze, by the method due to one of the authors (Shah, J. Indian Inst. Sc., 1924, 7, 205) and as there is a reactive amino group in the para position, it was thought interesting to obtain a number of derivatives of diphenyl benzamidine with different substituents in the para position by subjecting the base to the general reactions of the diazo compounds. The present paper deals with such reactions of diphenyl *p*-aminobenzamidine as also nitration and sulphonation of the base.

Diphenyl *p*-aminobenzamidine (I, R = NH₂) when diazotised and subjected to the Sandmeyer's reaction in presence of cuprous chloride solution gave the expected *diphenyl p*-chlorobenzamidine (I, R = Cl), which was also obtained from *p*-chlorobenzanilide by the method of Sidiki and Shah (J. Univ. Bombay, 1937-38, 6 (ii), 132). Similarly the diazotised diphenyl *p*-aminobenzamidine gave with cuprous bromide and potassium iodide, diphenyl *p*-bromo- and *diphenyl p*-iodo-benzamidines (I, R = Br and I) respectively. The same were also obtained from *p*-bromo- and *p*-iodo-benzanilides. All attempts to replace NH₂ by CN in diphenyl *p*-aminobenzamidine by the Sandmeyer's reaction proved futile. *Diphenyl p*-cyanobenzamidine (I, R = CN) could however be prepared from *p*-cyanobenzanilide, and was then hydrolysed to *diphenyl p*-carboxybenzamidine (I, R = COOH).



On boiling the diazotised solution from diphenyl *p*-aminobenzamidine the corresponding hydroxyl compound, namely diphenyl *p*-hydroxybenzamidine (I, R = OH), was formed. Attempts were made to prepare a hydroxy ketone from this (I, R = OH) by Friedel-Crafts reaction, but without success. Attempts at methylating the hydroxy compound were also unsuccessful. On Pechmann-Duisberg condensation with ethyl acetoacetate, it furnished *diphenyl (4'-methyl-α-pyrone)-5:6'-3:4-benzamidine (II)*.

Sulphonation of the *p*-aminobenzamidine (I, R = NH₂) with fuming sulphuric acid at the temperature of boiling water-bath gave a di-derivative probably *diphenyl 4-aminobenzamidine-3:5-disulphonic acid*. Nitration with concentrated nitric acid in concentrated sulphuric acid in ice-bath also gave a di-derivative, *diphenyl 3:5-dinitro-4-aminobenzamidine*. Attempts at bromination did not result in any pure workable product.

A number of other reactions of the base have also been attempted, but without success. Amongst these may be mentioned, the replacement of the NH₂ by H, NHHN₂, NBrNBr₂, NO₂ and SO₂H groups as also the replacement of the diphenyl type, and condensation with carbon disulphide and benzaldehyde. In these cases either the reaction did not take place to give the desired product or the compound formed was found to be incapable of isolation in a pure state.

EXPERIMENTAL

Diphenyl p-chlorobenzamidine (I, R = Cl).—Diphenyl *p*-aminobenzamidine (4 g.) was diazotised in the usual manner at 0°-5°C with concentrated hydrochloric acid (10 c.c.), water (10 c.c.) and sodium nitrite solution (1.2 g. in 4 c.c. water) and the clear diazotised solution was then added gradually to cuprous chloride solution (10% ; 28 g.) boiling gently under reflux when a yellowish hydrochloride separated immediately. Heating was continued for few minutes until the evolution of nitrogen was complete. The hydrochloride was crystallised from rectified spirit, tiny prisms, m. p. 270°-71°C (Found : Cl of HCl, 10.2. C₁₉H₁₅N₂Cl.HCl requires Cl, 10.3 per cent). The hydrochloride was dissolved in rectified spirit and then treated with liquor ammonia when crystals of *diphenyl p-chlorobenzamidine* separated. Crystallised from alcohol, m. p. 148°-50°C (1.5 g.) (Found : Cl, 11.3. C₁₉H₁₅N₂Cl requires Cl, 11.6 per cent).

The same compound was also obtained from *p*-chlorobenzanilide. *p*-Chlorobenzanilide, m. p. 195°C (Wegerhoff, Ann., 1889, 252, 7; Hantzsch, Ber., 1892, 24, 56) (2 g. ; 1 mol.) was condensed with aniline (1.2 g. ; 1.5 mol.) in presence of phosphorus oxychloride by the method of Sidiki and Shah (loc. cit.). After refluxing for five hours in an oil-bath at 140°-50°C the liquid was poured into ice-water, when a resinous mass separated which on keeping overnight in a frigidaire solidified to a white mass, crystallised from alcohol in colourless crystals, m. p. 271°-72°C (1.0 g.). The hydrochloride when decomposed as above furnished diphenyl *p*-chlorobenzamidine, m. p. 150°C (0.6 g.). Mixed melting point with the above specimen was undepressed.

Acetyl derivative crystallised from dilute rectified spirit, white prisms, m. p. 148-49°C (Found : N, 8.3. C₂₁H₁₇ON₂Cl requires N, 8.0 per cent)*.

Diphenyl p-bromobenzamidine (I, R = Br).—The diazotised solution of diphenyl *p*-aminobenzamidine (4.0 g.) was added in small amounts to cuprous bromide solution (20 g.) boiling gently when a yellow hydrochloride separated. It was collected and crystallised, yellow prisms.

from glacial acetic acid, m.p. above 285°C (1.5 g.) (Found : Cl, 9.7. Calculated for $\text{C}_{19}\text{H}_{15}\text{N}_2\text{Br.HCl}$: Cl, 9.2 per cent). Shirsat and Shah (unpublished work) give m.p. 292°C . Diphenyl *p*-bromobenzamidine obtained as before, crystallised from dilute rectified spirit, m.p. 161°C (1.0 g.) (Found : Br, 22.3. Calculated for $\text{C}_{19}\text{H}_{15}\text{N}_2\text{Br}$: Br, 22.8 per cent). Shirsat and Shah (loc.cit.) give m.p. 175°C .

The same bromo compound has also been obtained by the condensation of *p*-bromobenzanilide (2 g.) with aniline (0.7 g.) using phosphorus oxychloride (14 g.). The hydrochloride, m.p. above 285°C (1.5 g.), when decomposed gave diphenyl *p*-bromobenzamidine, m.p. 165°C . Mixed melting point with the above product by Sandmeyer's reaction was not depressed.

Diphenyl p-iodobenzamidine (I, $R=I$).—To the cooled diazotised solution of diphenyl *p*-aminobenzamidine (1 g.), a solution of potassium iodide (0.8 g.) in water (1.6 c.c.) was slowly added with constant stirring. The whole mixture was then heated on a boiling water-bath, till evolution of nitrogen ceased (about half an hour). A yellowish brown hydrochloride separated which could not be crystallised and was purified by repeated boiling with acetone when the pure *hydrochloride* remained as a yellow solid, m.p. $275^{\circ}\text{--}76^{\circ}\text{C}$ (0.2 g.) (Found : Cl, 8.2. $\text{C}_{19}\text{H}_{15}\text{N}_2\text{I.HCl}$ requires Cl, 8.2 per cent). *Diphenyl p-iodobenzamidine* (I, $R=I$) from the hydrochloride, crystallised from rectified spirit, needles m.p. $175^{\circ}\text{--}77^{\circ}\text{C}$ (0.1 g.) (Found : I, 31.7. $\text{C}_{19}\text{H}_{15}\text{N}_2\text{I}$ requires I, 31.9 per cent).

The same *p*-iodobenzamidine was also obtained from *p*-iodobenzanilide (3 g.), aniline (1.3 g.) and phosphorus oxychloride (21 g.). The hydrochloride which was obtained, gave on grinding with ammonia, diphenyl *p*-iodobenzamidine, crystallised from dilute rectified spirit, m.p. $176^{\circ}\text{--}77^{\circ}\text{C}$. Mixed melting point with the above specimen was not depressed.

Acetyl derivative, crystallised from dilute rectified spirit, colourless prisms, m.p. $142^{\circ}\text{--}43^{\circ}\text{C}$ (Found : N, 6.9. $\text{C}_{21}\text{H}_{17}\text{ON}_2\text{I}$ requires N, 6.4 per cent)*.

Diphenyl p-cyanobenzamidine (I, $R=\text{CN}$).—All attempts to prepare this compound from diphenyl *p*-aminobenzamidine by Sandmeyer's reaction using cuprous-potassium cyanide met with failure as no crystallisable product could be obtained. However, it was prepared from *p*-cyanobenzanilide.

p-Cyanobenzanilide was prepared from *p*-cyanobenzoic acid by the method of Shah and Deshpande (J. Univ. Bombay, 1933-34, 2, 126). *p*-Cyanobenzoic acid (5 g.) was mixed with phosphorus pentachloride (9.5 g.) when a vigorous reaction occurred. The reaction mixture protected from moisture was heated on a water-bath for 15 minutes. Pyridine (6.3 g.) was added to it followed by aniline (4.8 g.), the latter slowly and with shaking. It was kept in an ice-bath for half an hour and then heated on a water-bath for 15 minutes. The dark liquid obtained was poured in ice cold dilute hydrochloric acid. A viscous mass separated which solidified on keeping. *p*-Cyanobenzanilide

was crystallised from dilute rectified spirit, tiny white crystals, m.p. 175°-76°C. Fischer and Walter (J. pr. Chem., 1909, (ii) 80, 102; prepared it by the oxidation of *p*-cyanobenzylaniline in acetone by aqueous potassium permanganate and give m.p. 178°-79°C.

p-Cyanobenzanilide (4 g.) when condensed with aniline (2.5 g.) in presence of phosphorus oxychloride (28 g.) by the method of Sidiki and Shah gave first the *hydrochloride*, m.p. 285°C (2 g.), which was converted into the free base, *diphenyl p-cyanobenzamidine* (I, R=CN), prisms from dilute alcohol, m.p. 193°-94°C (Found : N, 14.3. $C_{20}H_{15}N_3$ requires N, 14.1 per cent)*.

Diphenyl p-carboxybenzamidine (I, R=COOH).—The above benzamidine (I, R=CN) (0.3 g.) was dissolved in alcohol and treated with potassium hydroxide solution (10% ; 10 c.c.), and the clear solution refluxed for about 22 hours. After removal of alcohol, the residue was acidified with acetic acid, when *diphenyl p-carboxybenzamidine* separated, crystallised from rectified spirit, m.p. above 290°C (0.2 g.) (Found : N, 8.5. $C_{20}H_{16}O_2N_2$ requires N, 8.9 per cent)*.

Diphenyl p-hydroxybenzamidine (I, R=OH).—Diphenyl *p*-aminobenzamidine (4 g.) was treated with a mixture of concentrated sulphuric acid (3 c.c.) and water until a clear solution resulted. The latter was then cooled to 0-5°C and diazotised in the usual manner with a cooled solution of sodium nitrite (1 g. in 4 c.c. of water). The diazotised solution was then heated first on boiling water-bath and then on wire-gauze for about 10 minutes until the evolution of nitrogen was complete. On cooling the clear liquid was decanted off and made alkaline with dilute sodium hydroxide solution (10%). The alkaline suspension was then poured into a large excess of water and carbon dioxide passed into the filtrate when diphenyl *p*-hydroxybenzamidine (I, R=OH) separated, crystallised from alcohol, m.p. 213-14°C (Found : N, 10.3. Calculated for $C_{19}H_{16}ON_2$: N, 9.7 per cent)*. Shirsat and Shah (loc.cit.) give m.p. 216°C. The sticky solid which remained after decanting of the clear liquid on treatment with alkali and passing carbon dioxide through the resulting suspension gave an additional amount of the same (total yield 1.5 g.).

When diphenyl *p*-aminobenzamidine (4 g.) was diazotised in hydrochloric acid and heated, the hydrochloride of diphenyl *p*-hydroxybenzamidine separated, crystallised from glacial acetic acid in plates, m.p. 286-87°C (2.0 g.) (Found : Cl, 10.5. Calculated for $C_{19}H_{16}ON_2 \cdot HCl$: Cl, 10.9 per cent). Shirsat and Shah (loc. cit.) give m.p. 290°C. The hydrochloride when dissolved in caustic soda solution and carbon dioxide passed, furnished the free base, m.p. 213°-14°C.

O-Acetyl derivative, crystallised from rectified spirit, white prisms, m.p. 110-11°C (Found : N, 8.4. $C_{21}H_{18}O_2N_2$ requires N, 8.5 per cent)*. It is insoluble in alkali in cold.

Pechmann Condensation of Diphenyl p-hydroxybenzamidine with Ethyl Acetoacetate : *Diphenyl (4'-methyl- α -pyrono) - 5' : 6' - 3 : 4-benzamidine* (II). Diphenyl *p*-hydroxybenzamidine (0.5 g.) was mixed with ethyl acetoacetate (0.2 c.c.) and concentrated sulphuric acid (2 c.c.) was slowly

added. It was then kept overnight and then poured into ice-water. The solid separated was washed with bicarbonate solution and then with cold benzene. *Diphenyl (4'-methyl- α -pyrro) - 5' : 6'-3 : 4-benzamidine* (II) which was thus obtained was purified by repeated boiling with acetone, m.p. 280° - 82° C (0.04 g.) (Found : N, 8.3. $C_{23}H_{18}O_2N_2$ —requires N, 7.9 per cent)*.

Diphenyl 3 : 5-dinitro-4-aminobenzamidine. To diphenyl *p*-aminobenzamidine (1 g.) in concentrated sulphuric acid (d. 1.81 ; 4 c.c.) was gradually added with constant shaking concentrated nitric acid (d. 1.4 ; 0.5 c.c.) keeping the reaction flask immersed in an ice-bath. It was kept for half an hour, poured into water and then made alkaline with sodium hydroxide solution (10%). *Diphenyl 3 : 5-dinitro-4-aminobenzamidine* that separated was washed with boiling methanol and crystallised from pyridine and water, m.p. 257° - 59° C (0.15 g.) (Found : N, 18.9. $C_{19}H_{15}O_4N_5$ requires N, 18.6 per cent)*.

Diphenyl 4-aminobenzamidine-3 : 5-disulphonic acid.—Diphenyl *p*-aminobenzamidine (2 g.) and fuming sulphuric acid (2 c.c.) were mixed and the mixture protected from moisture was heated on a boiling water-bath for 4 hours. It was then poured into water, filtered and the filtrate neutralised with barium carbonate. It was again boiled, barium sulphate removed by filtration, and the filtrate evaporated to dryness. The barium salt was then treated with calculated amount of standard sulphuric acid, boiled and filtered off the insoluble residue of barium sulphate. The filtrate was evaporated, and *diphenyl 4-aminobenzamidine-3 : 5-disulphonic acid* thus obtained was crystallised from water, colourless crystals (0.5 g.). It did not melt but charred at high temperatures (Found : S, 13.4. $C_{19}H_{17}O_6N_3S_2$ requires S, 14.3 per cent).

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* The analyses of compounds marked with asterisk are micro-analyses carried out by Mr. P. L. Trivedi at the Institute.

A NEW SYNTHESIS OF α -NAPHTHYLACETIC ACID

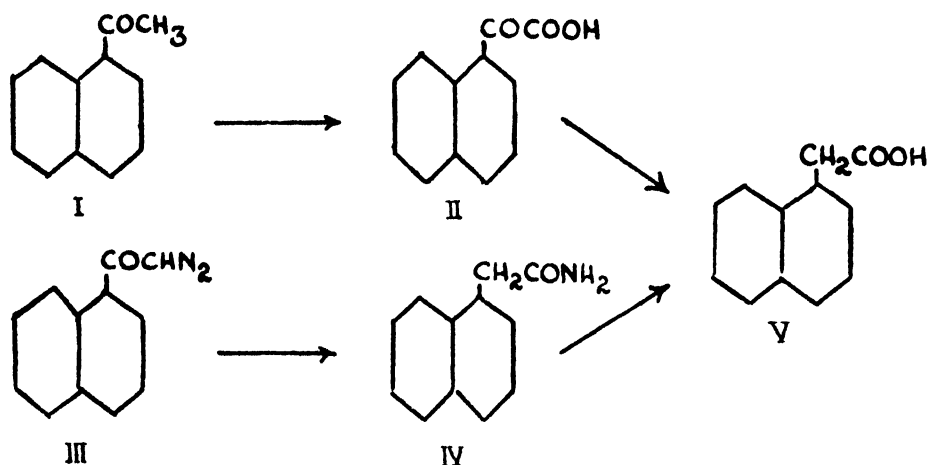
By A. T. JAVERI, G. V. JADHAV AND R. C. SHAH

WITH indole-3-acetic acid and indole-3-butyric acid, α -naphthylacetic acid also is an important auxin required for the growth of plants and a number of methods are known in literature for its synthesis. Boessneck (Ber., 1883, 16, 641) first prepared it starting from α -naphthoyl chloride, converting it to α -naphthoyl cyanide, hydrolysing it to the keto-acid which on reduction gave α -naphthylacetic acid. Willgerodt (ibid., 1887, 10, 2468 ; 1888, 21, 534 ; J. prakt. Chem., 1910, (2) 81, 387) obtained the amide of the acid (with some ammonium salt of the acid) from methyl α -naphthylketone by transformation with yellow ammonium sulphide and sulphur, by heating it in a sealed tube. Tiffeneau and Daudel (Compt. rend., 1908, 147, 679) prepared it by oxidation of α -naphthylacetaldehyde. It has also been prepared from α -chloromethylnaphthalene, obtained by reaction of naphthalene with formaldehyde in presence of hydrochloric acid or from α -chloro- or α -bromo-methylnaphthalene obtained by chlorination or bromination of α -methylnaphthalene. The α -chloro- or α -bromo-methylnaphthalene is then converted to the nitrile and the latter then hydrolysed to the acid (Wislicenus and Wren, Ber., 1905, 38, 506 ; Mayer and Oppenheimer, ibid., 1916, 49, 2139 ; Wilcoxan, Contrib. Boyce Thomson Inst., 1935, 7, 439 ; Cambron, Can. J. Research, 1939, 17B, 10 ; Manske and Ledingham, ibid., p. 14 ; Robin and Hechenbleikner, C. A., 1939, 33, 8628 ; Tamari, J. Agr. Chem. Soc. Japan, 1940, 16, 340). By the Friedel-Crafts reaction between naphthalene and ethyl chloroglyoxylate, Rousset (Bull. Soc. Chim., 1897, (3) 17, 300) obtained α -ketonic ester which on reduction gave α -naphthylacetic acid (see also Wilcoxan, Contrib. Boyce Thomson Inst., 1937, 8, 46). Mauthner (J. prakt. Chem., 1917, (2) 95, 55) prepared it from α -naphthylacetaldehyde through a number of stages. Patents have been taken on its preparation from naphthalene and chloracetic acid (I. G. Farbenind. A. -G., Brit. P. 1929, 330, 916 ; Ger. P. 1929, 562, 391 ; U. S. P. 1934, 1,951,686). Keach (J. Am. Chem. Soc., 1933, 55, 2975) gives still another synthesis from α -allylnaphthalene where it is formed along with α -naphthoic acid and α -naphthylmethylethylene glycol (cf. Higginbottom and Short, Rec. trav. Chim., 1934, 53, 1141).

As α -naphthylacetic acid was required for some other work its methods of preparation were investigated.

Attempts were first made to synthesise it from methyl α -naphthyl ketone (I) by oxidation to the keto-acid (II) which could subsequently be reduced to α -naphthylacetic acid (V). This oxidation of the ketone

has been carried out by Claus and Feist (Ber., 1886, 19, 3180) with potassium permanganate in aqueous solution in cold. Oxidation was carried out under various conditions. However the yield of the keto-acid was very poor as the oxidation did not stop with the formation of the keto-acid but proceeded further giving α -naphthoic acid.



A new synthesis of α -naphthylacetic acid was then investigated, on the same lines as the preparation of 6-methoxycoumarone-2-acetic acid from 6-methoxycoumarone-2-carboxylic acid (McGookin, Robertson and Whalley, J. Chem. Soc., 1910, 787).

α -Naphthoyl chloride was converted into diazomethyl α -naphthyl ketone (III) by the action of ethereal solution of diazomethane (cf. Bradley and Robinson, *ibid.*, 1928, 1310). In this reaction it was observed that twice the theoretical amount of diazomethane is required to which an ethereal solution of the acid chloride should be added. If this is followed then the yield of diazo-ketone is good, as hydrochloric acid which is produced is destroyed by the excess of diazomethane present. Otherwise this hydrochloride reacts with the diazoketone to give *o*-chloromethyl α -naphthyl ketone (cf. Arndt and Amende, Ber., 1928, 61, 1122).

Diazomethyl α -naphthyl ketone could not be isolated in a pure state. Hence its solution in dioxan was directly treated with aqueous silver nitrate and ammonium hydroxide when the amide of α -naphthylacetic acid was obtained in 57 per cent yield (cf. McGookin, et al., *loc. cit.*). On hydrolysis it gave α -naphthylacetic acid. Thus the total yield from α -naphthoic acid was 36 per cent.

α -Naphthylacetic acid was also prepared from α -methylnaphthalene through α -bromomethyl- and α -chloromethylnaphthalenes (Wislicenus and Wren, *loc. cit.*; Mayer and Oppenheimer, *loc. cit.*). During chlorination much tarry products were obtained; bromination was however smooth and gave good results. The α -chloro- and α -bromo-methylnaphthalenes were then converted into the nitrile which on hydrolysis furnished α -naphthylacetic acid (V).

EXPERIMENTAL

Diazomethyl α -naphthylketone (III) :—A solution of α -naphthoyl chloride (9.5 g.) in dry ether (50 c.c.) was added during the course of 5 minutes to a solution of diazomethane (Org. Synthesis, Vol. XV, p. 3) (4.5 g.) in ether (250 c.c.) with cooling in ice. A vigorous evolution of nitrogen took place in the beginning. After keeping overnight, the ether was removed in vacuum, as the substance appeared to decompose on heating. The diazoketone (III) was obtained as a yellow oil and could not be purified.

α -Naphthylacetamide (IV) :—The oil (obtained above) was dissolved in dioxan (150 c.c.) in cold. It was then heated on a steam-bath while liquor ammonia (70 c.c.) followed by silver nitrate solution (30 per cent; 25 c.c.) were added with vigorous stirring. More of liquor ammonia (20 c.c.) was then added and heating continued for half an hour. The solution was filtered, cooled and extracted with ether. The ether extract, after drying and removal of ether gave α -naphthylacetamide, crystallised from hot water, m.p. 178°-80°C (5.2 g.; 57%). Boessneck (loc. cit.) gives m.p. 180°-81°C.

α -Naphthylacetic acid (V) :—To a solution of α -naphthylacetamide (2.0 g.) in little alcohol a solution of potassium hydroxide (20%; 30 c.c.) was added and refluxed for 4 hours. α -Naphthylacetic acid which separated on acidification was crystallised from water, m.p. 129°-30°C (1.6 g.). Boessneck (loc. cit.) and Tiffeneau and Daudel (loc. cit.) give m.p. 131°C.

α -Chloromethylnaphthalene :—It was prepared by the method of Wislizenus and Wren (loc. cit.) by chlorination of α -methylnaphthalene (50 g.). α -Methylnaphthalene (20 g.) was recovered and α -chloromethylnaphthalene (20 g.) was obtained.

α -Bromomethylnaphthalene :— α -Methylnaphthalene (50 g.) was brominated by the method of Mayer and Oppenheimer (loc. cit.) and the crude product was directly used for further work.

α -Naphthylacetoneitrile :—(A) α -Chloromethylnaphthalene (10 g.) when treated with sodium cyanide (6 g.) in alcohol (80 c.c.) and water (12 c.c.) gave the nitrile (4.3 g.).

(B) The crude α -bromomethylnaphthalene on similar treatment with sodium cyanide (30 g.) alcohol (500 c.c.) and water (80 c.c.) also gave the nitrile (32 g.).

α -Naphthylacetic acid (V) :— α -Naphthylacetoneitrile (32 g.) was hydrolysed with potassium hydroxide solution (30 per cent; 200 c.c.) and hydrogen peroxide (20 Vol.; 79 c.c.). α -Naphthylacetic acid that separated on dilution and acidification was crystallised from water, m.p. 129°-30°C (28 g.).

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A STUDY OF THE OIL FROM THE SEEDS OF

'Ipomoea Muricata' (N. O.: Convolvulacæ)

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THE plant, *Ipomoea Muricata* (Marathi : Bhora ; Hindi : Mirchi) is found in konkan and Deccan hills. It is a large climber with stems often muricated. Seeds are 1.0 cm. long with smooth and polished black colour when mature. The seeds are used in konkan as country medicine and the whole plant is also used to kill bugs.

The seeds were extracted with petroleum ether. The petroleum ether was distilled off on water bath and the last traces of ether were removed under reduced pressure. The fatty oil from the seeds of '*Ipomoea Muricata*' has been studied by Bhide and co-workers (J. Indian Chem. Soc., 1947, 24, 87.) But the Chemical constants and also the percentages of the fatty acids in the oil, as determined by them greatly differ from those observed by us. It may be possible that the seeds belong to a different variety of the species.

TABLE No. I

Physical and Chemical Constants

Yield	9.50 per cent
Specific gravity	0.9232 at 26°C
Refractive Index	1.4860 „
Saponification Value	201.30
Iodine Value	109.4 **
Acid Value	5.7
Acetyl Value	14.4
R. M. Value	1.34
Polenski Number	0.81
Unsaponifiable matter	1.40 per cent

The insoluble fatty acids :

The oil was saponified by means of alcoholic potassium hydroxide and the soaps were dissolved in large quantity of water. The unsaponifiable matter was extracted with ether and the free acids were liberated

**Iodine value of the oil studied by Bhide and others. (J. Indian Chem. Soc. 1947 24, 90) is 68.57. Our thanks are due to Mr. K. T. Joshi for the collection of seeds and some preliminary work.

by acidifying the soaps with hydrochloric acid. The acids liberated were taken up in ether and the ether extract was washed free from hydrochloric acid. The ether solution was then dried over anhydrous sodium sulphate and filtered. The ether was distilled off and the mixed fatty acids thus collected were further dried over calcium chloride in vacuum dessicator. The mixed fatty acids gave the following values :

TABLE No. II

Mixed fatty acids

Yield	83.5 per cent
Titre Value	35-37°C
Acid Number	194.05
Mean Molecular Weight	288.6
Iodine Value	129.2

The combined solid and liquid fatty acids were then separated into liquid (unsaturated) and solid (saturated) fatty acids by the precipitation of the solid fatty acids with lead acetate in alcoholic solution. (E. Twitchell).

TABLE No. III

Separation of the fatty acids

Mixed acids (taken)	65.5 gms.	—
Solid acids (obtained) .. .. .	.....	18.2 gms.
Liquid acids ,, .. .. .	.....	46.8 gms.
Loss .. .. .	.....	0.50 gms.

18.2 gms. of the saturated (solid) acids mentioned above were obtained from the different crops of the solid lead salts by decomposing them with dilute nitric acid. The liberated acids were taken up in ether and dried over anhydrous sodium sulphate and filtered. The ether was distilled off and the acids thus obtained gave the following results :

Crop	Weight of lead salts (gms.)	Weight of acids (gms.)	M. P.	Molecular weight
1	7.25	6.53	58°C	286.2
2	6.18	5.62	57°C	286.0
3	5.32	4.85	57°C	285.4
4	2.10	1.20	56°C	285.10

TABLE No. IV

Solid (saturated) acids

Melting point	58°C
Neutralisation Value	195.8
Mean molecular weight	285.95
Iodine value	2.59

The solid (saturated) acids as obtained above were then turned into their methyl ester by refluxing the acids with methyl alcohol saturated with dry hydrochloric acid gas. 11.4 gms. of these esters were then distilled under reduced pressure (2 to 8mm.) and the following fractions were obtained:

TABLE No. V

Fraction	Temperature	Weight of methyl esters	S. V.	Mean Molecular weight
1	upto 160°C	1.0805 gms.	202.0	277.8
2	160°-165°C	3.2851 gms.	197.2	284.5
3	165°-170°C	2.6736 gms.	192.8	291.1
4	170°-175°C	1.1102 gms.	184.7	303.8
5	175° onwards	1.7691 gms.	174.1	322.2
6	Residue	1.2530 gms.	....	....
Total ..	.. .. .	11.1715 gms.		

Each of these fractions of the methyl esters was hydrolysed separately with potassium hydroxide and the corresponding fractions of the fatty acids were obtained by acidifying the soaps with hydrochloric acid. Mean molecular weights and melting points of the different fractions (corresponding to the—fractions of the methyl esters in table No. V). are given in the following table:

TABLE No. VI

Fraction	M.P.	Weight of acids (corresponding to esters in Table V)	Neutra- lisation value	Mean Mol. weight	Percentages		
					Palm- itic	Stea- ric	Be- henic
1	56°C	1.030 gms.	212.8	263.6	72.86	27.14	..
2	56°C	3.130 gms.	207.77	270.0	50.0	50.0	..
3	61°C	2.547 gms.	203.10	276.2	27.86	72.14	..
4	69°C	1.057 gms.	193.7	289.6	..	90.0	10.0
5	71°C	1.684 gms.	182.0	308.2	..	57.14	42.86
6	72°C	1.193 gms.	171.3	327.5	..	22.32	57.68

The free acids thus obtained from the methyl esters were further separated into individual acids by fractional precipitation of their magnesium salts. Acids were recovered from the magnesium salts and crystallised from methyl alcohol. The first three fractions showed the presence of palmitic and stearic acids only and no behenic acid was traced in these fractions. The last three fractions showed the presence of stearic and behenic acids only and no palmitic acid was traced in these fractions. The approximate percentages of the individual acids (in the solid portion) are calculated on these bases:

Palmitic acid	..	..	..	..	28.42 per cent
Stearic acid	..	..	..	..	55.10 per cent
Behenic acid	..	..	..	..	16.48 per cent
Constituting	..	..	..	..	27.80 per cent of the total fatty acids.

Unsaturated (liquid) acids :

After the removal of the solid acids as insoluble lead salts of the saturated acids, the liquid acids were liberated with dilute hydrochloric acid from their lead salts and extracted with ether. They were washed and then dried over anhydrous sodium sulphate. On removing the ether liquid fatty acids were recovered. The acids, thus obtained, were found to have a deep yellow colour and gave the following values.

TABLE No. VII
Unsaturated (liquid) acids

Iodine value	..	..	..	..	..	175.8
Neutralisation value	..	..	..	..	..	194.15
Mean Molecular weight	..	..	..	..	..	286.70

The liquid fatty acids yield an insoluble hexabromide and so the bromination of the liquid acids was carried out in dry ether (Sulphuric). 10.0 gms. of the liquid fatty acids were dissolved in dry ether and the solution was cooled in ice. A cold solution of bromine in the same solvent was then gradually added to the solution of the liquid fatty acids with constant stirring. The reaction mixture was then left overnight in ice-box. Next day a small quantity of a solid bromoderivative was obtained, which was filtered off and washed with ether.

Yield	..	..	..	5.6 gms.
Melting point	..	..	..	180°C-181°C
Bromine content	..	..	..	63.29 per cent (Found)
Bromine content	..	..	..	63.31 per cent (Required by : $C_{18}H_{30}O_2Br_6$)

Hence this precipitate would correspond to 2.04 gms. of *Linolenic acid*.

From the filtrate and the washings the ether was removed and the excess of bromine was completely washed off with a dilute solution of sodium thiosulphate and water. The liquid mass was then mixed with petroleum ether and rubbed for a long time. A solid derivative was obtained which was filtered and washed with petroleum ether.

Yield	8.976 gms.
Melting Point	114°C
Bromine content	53.18 per cent (Found)
Bromine content	53.33 per cent (Required by : $C_{18}H_{32}O_2Br_4$)

Hence this precipitate would correspond to 4.194 gms. of *Linolic acid*.

On removing the petroleum ether a thick red viscous oil was obtained

Yield	6.4 gms.
Bromine content	41.87 per cent (Found) by
Bromine content	36.20 per cent Required : $C_{18}H_{34}O_2Br_2$

The high value of the bromine content shows that this portion corresponds to a mixture of tetra-bromo-stearic acid and di-bromo-stearic acid. Calculating on this basis, 6.4 gms. of the mixture corresponds to :

2.124 gms. of tetra bromo-stearic acid,
corresponding to.....0.991 gms. of *Linolic acid*.

4.276 gms. of dibromo-stearic acid.
corresponding to.....2.73 gms. of *Oleic acid*.

Thus,

10.0 gms. of the liquid fatty acids gave on bromination :

5.6 gms. of hexa-bromo-stearic acid,
corresponding to.....2.04 gms. of *Linolenic acid* 8.976 gms.

of tetrabromo-stearic acid,
corresponding to.....4.194 gms. of *Linolic acid*.

2.124 gms. of tetra-bromostearic acid,
corresponding to.....0.991 gms. of *Linolic acid*.

4.276 gms. of dibromo-stearic acid,
corresponding to.....2.73 gms. of *Oleic acid*.

Hence the composition of the unsaturated acids :

Linolenic acid	..	..	..	..	20.40 per cent
Linolic acid	..	..	..	..	51.85 per cent
Oleic acid	..	..	..	..	27.30 per cent
Constituting	..	..	..	..	72.20 per cent of the total fatty acids.

*Summing up, the total insoluble fatty acids in the oil are :

Solid (saturated) acids :	Palmitic acid....	7.9 per cent
27.80 per cent	Stearic acid....	15.31 per cent
	Behenic acid....	4.59 per cent
Liquid (unsaturated) acids	Linolenic acid..	14.73 per cent
72.20 per cent	Linolic acid....	37.43 per cent
	Oleic acid.....	20.04 per cent

Unaponifiable Matter :

The ethereal washings of the soap were washed with water. The ether was removed and the solid compound thus obtained was crystallised from alcohol. M.P. 131°-133°C.

This unsaponifiable matter gave all the colour reactions characteristic of common phytosterols.

CHEMISTRY DEPARTMENT,
RAJARAM COLLEGE,
KOLHAPUR.

[Received: February 7, 1949]

*The composition of the insoluble fatty acids in the oil studied by Bhide and others (J. Ind. Chem. Soc. 1947, 24, 90) is given below for comparison :

Palmitic acid	13.66%	} 40% Solid (saturated) acids.
Stearic acid	..	..	..	22.55%
Behenic acid	..	..	..	3.70%
Linolenic acid	3.918%	} 60% Liquid (unsaturated) acids.
Linolic acid	..	..	..	15.15%
Oleic acid	..	..	..	40.97

ABSTRACT OF THESES

Dielectric Constants of Liquids and Solids

By B. R. YATHIRAJA IYENGAR

A NEW relationship between the dielectric constant and dipole moment ($\epsilon - n^2$) $\frac{M}{d} = \frac{4\pi N \mu^2 (j+1)}{3KTj}$ where $j = \infty$ for gases and $\frac{1}{2}$ or 1 for liquids and solids has been derived from the considerations of quantised orientations similar to those applied in the magnetic case. These are also inherent in the previous theories of hindered rotation, parallel and antiparallel orientations postulated by Debye.

The experimental verifications and limitations of the previous equations of Debye, Onsager, Wyman, Frölich and others., in the case of dilute solutions and pure liquids have been shown to be due to their fortuitously approximating to the new equation.

The equation for anomalous dispersion has been derived on the basis of the new theories. The previous equation of Debye, Cole, Fuoss and others have been critically reviewed.

Analogous to the introduction of a Curie temperature in paramagnetics, the ferroelectric substances like rochelle salt and titanates show a characteristic temperature ' θ '. The most general equation previously derived connecting dielectric constant and dipole moment now becomes

$(\epsilon - n^2) \frac{M}{d} = \frac{4\pi N \mu^2}{K(T-\theta)}$. The introduction of ' θ ' successfully explains the temperature coefficients of the dielectric constants of a number of liquids and solids. It is found that ' θ ' is near the melting point for associated liquids and transition point for crystalline solids.

The new relationship has been successfully applied to interpret the high dielectric constants of a large number of liquids, and solids showing molecular rotation.

(1) Organic halides :—The dielectric constants and densities of '*normal*', '*iso*' and '*tertiary*' amyl chlorides, bromides and iodides, '*ortho*', '*meta*' and '*para*' chloro and bromo toluenes, chloro and bromo cyclohexanes,

'tertiary' butyl chloride, 'iso' butyl chloride and bromide and 'iso' propyl bromides have been determined and dipole moments calculated and quantitatively interpreted on basis of molecular structure.

(2) *Associated liquids* :—The dielectric constants of water, methyl, ethyl, propyl, butyl and amyl alcohols, hydrocyanic and hydrofluoric acids have been studied. The characteristic temperature ' θ ' for alcohols coincides with the melting point. The moments given by the new equation conform with the vapour values.

(3) *Amino acids and Proteins* :—The dielectric constants of aqueous solutions of α , β , γ , δ , ϵ and ξ amino acids, peptides, betaines, urea and its homologues have been interpreted by the new equation in the light of 'Zwitterion' structure. The proteins, myoglobin, gliadin, zein, carboxy-haemoglobin, albumin and pseudoglobulin have been studied in aqueous solutions. The moments as well as the '*molecular radii*' calculated by the new equation, have been correlated.

(4) *Plastics* :—The dielectric constants of polyvinyl chloride, polyvinyl chloroacetate, polychloro-styrene, polychloroprene, polyvinyl acetate, polymethyl acrylate, polymethyl methacrylate, cellulose esters, 'w' hydroxy-decanoic acid, polymethyl siloxane, vulcanized rubber and acrylonitrile-ethyl acrylate copolymers have been interpreted by the new equation to calculate moments as functions of temperature, plasticizer or solvent content and polymerization degree. The moments have been interpreted quantitatively on the basis of Jatkari's component law of addition of bond moments.

(5) The dielectric constants of rochelle salt, titanium dioxide, calcium, barium and strontium titanates have been explained by the new equation including a characteristic temperature ' θ ' which corresponds to the temperature of absorption maxima at which the dielectric constant rises from a low value to a maximum peak. Silica also shows a similar behaviour. The moments have been further calculated from the structure.

NOTES AND NEWS

The Mobilization of Spiritual Forces

THERE has been a world crisis in human affairs for the last many years. The causes of the crisis were supposed to be political and economic. One should have expected the crisis to have been resolved as a result of the two great World Wars. This has not been the case, however. This diagnosis does not seem, therefore, to be correct. A correct diagnosis would have led to the solution of the crisis ere long, particularly in view of the fact that there has been so much genius and talent in the world, that there have been brought under control such mighty forces of nature as a result of the great discoveries and inventions by scientists and engineers that a right use of them would easily solve the many complicated problems facing the world at the present day. This hope has not, however, been fulfilled. This has, naturally, led the great statesmen of the world to go deeper into the question and inquire why in spite of so many far-reaching researches and so many intellectual giants in the world, the crisis has not yet been successfully tackled. What is wrong with the world and why is it going the wrong way? This was a very pertinent question put by Pandit Jawaharlal Nehru to the distinguished scientists, both Indian and Overseas, assembled at the annual Sessions of the Indian Science Congress held in Allahabad in the first week of January 1949. He asked them to probe deeper into the causes of the crisis.

Sir Stafford Cripps, British Chancellor of the Exchequer, in one of the statements made recently by him, explained the world crisis by saying : "The world crisis is basically a moral rather than a political or economic crisis". After having made this diagnosis he further said : "If ever we are to see the triumph of our civilization, it will be brought about not by our material ingenuity but by our moral strength", and then recommended "some form of personal religion" which, he said, "was essential to maintaining the vitality of the spirit".

It is now beginning to dawn upon the leaders and statesmen of the world that "knowledge alone, science alone, brains alone"¹ is *not enough* to solve our present-day complicated problems, be they economical or political, industrial or commercial, social or educational. A spiritual background is necessary for their solution. *What is wanted is a mobilization of the spiritual forces of man.* The world crisis is psychological. There has been a psychological dislocation of man. And unless and until that is set right and a proper readjustment made by giving Spirit, the Inner Ruler Immortal, the rightful place in the constitution of man, there seems to be little chance of the crisis ever being resolved.

¹ J. Univ. Bombay, 12, Part III, November 1943, 12, Part V, March 1944 and 13, Part V, March 1945.

In the message which Pandit Jawaharlal Nehru has sent to Dr. Radha Kamal Mukherjee, Convener of the Conference on Culture, Religion and Morals to be held in Lucknow on March 5 and 6, he has rightly laid stress on the importance of moral values. Panditji says : "Consideration of cultural and moral values and standards is essential if we have to solve the problems that affect the world today. The most noticeable feature of the world of today, including India, is the divorce between the moral and cultural standards and the business of life". Quite true.

Pandit Jawaharlal Nehru, Premier of India, deserves to be congratulated on the generous support and encouragement he has given to scientific research, both pure and applied, by having an adequate number of scientific and technological research laboratories and institutions started in different parts of the country and making suitable provision for their equipment and efficient working. This is excellent so far as it goes and is absolutely necessary for a country like ours which is not thoroughly explored and exploited so far, both scientifically and technologically. *But it is not enough.* The chief drawback in our present system of education is the lopsided development of the individual. The present emphasis on the intellectual development requires to be supplemented by starting, side by side with the existing city institutions, Garden Universities in ideal natural surroundings far away from the din and noise, hurry and bustle, of the city atmosphere, where the students may come in close contact with nature, and where a greater emphasis will be placed on the study of humanities and on the art of living a simple, clean, noble life of service and sacrifice and where there will be exploration, more of man's own self as to what he really is, what his purpose in life, what his goal and destiny, than of the outside material world which will of course be carried on in the City Universities. The courses of study will have to be so devised in these Garden Universities that the students there will go through a regular training in Raja Yoga Discipline adapted to the modern conditions of life, and that there will be a greater scope for the development of heart and higher emotions. In that way there will be *a proper balance between the head and the heart development.* This will restore the balance which has been disturbed. This, again, will serve as an antidote to the danger of a lopsided development of the nation. This will bring about the right adjustment. This will bring about a change on the psychological level and consequently, a change of heart and a change of mental attitude.

That this proposal for the establishment of Garden Universities is a sound proposition will be seen from the following views of Dr. Annie Besant who was a great thinker and who was also a great genius in *practical* human affairs. She has spoken about the subject we are considering above so clearly and so *emphatically* that it is worth while reproducing here her views as they will be found to be very useful and suggestive to those who are responsible for laying down policies for their groups or communities, big or small.

"It is a very common blunder made by many people to suppose that spiritual forces have in them something which they are pleased to call unpractical, and we continually notice an assumption, which is taken for granted without argument, that if a nation, for instance, should turn itself towards a spiritual ideal, or if individuals should

devote themselves to the spiritual life, then such a nation is likely to be undistinguished along other more evident and visible walks in life, and such an individual is likely to lose much of what is called his practical value in the world. Such a view of life is a blunder and a blunder of the most complete kind. The liberation of spiritual forces, the setting free of energies on the spiritual plane has a far greater effect both on the individual and on the nation in the other regions of its activity than can be produced by any of the forces that are started on the lower planes of life. So that it is true in history, as you may find by study, that when spiritual forces are liberated the intellectual life of the nation will also leap forward with tremendous energy, the emotional life of the nation will show fresh development, and even on the lowest plane of all, the physical, results will be brought about entirely beyond anything that could have been achieved by the energies of the physical plane which are set to work and which apparently cause these results. That is a principle, a law, which I will ask you to bear in mind, that every force initiated on the higher planes, as it passes down to the lower, brings about results proportionate to itself; so that it is the shortest-sighted view of human life, and of human activity which imagines that devotion to the spiritual life, the evolution of the individual in the spiritual world, is anything but an immense addition to all the forces of progress that work on the earth, anything but a lifting up of the world on the great ladder up which it is climbing".¹

D. D. KANGA

¹ Annie Besant: *Evolution and Occultism, Essays and Addresses*, Vol. III, pp. 181-183.

OBITUARY

**The Late Dr. N.L. Phalnikar, M.Sc., Ph.D., A.R.I.C., A.Inst.P.
1914 — 1948**

DR. NAGESH LAXMAN PHALNIKAR was born at Agra on 27th July 1914. After matriculating he joined the Willingdon College, Sangli and after passing the Intermediate examination from that College he joined Gujarat College, Ahmedabad. Here he came under the influence of Dr. Nargund and under his guidance and inspiration, Dr. Phalnikar started research work in Chemistry in 1934. For his work on three-carbon tautomerism he was awarded the M.Sc. degree in Chemistry in 1936.

In 1938 he was appointed Professor of Chemistry in Sir Parashurambhau College, Poona, where he continued active work along with several Post-graduate students till his death in 1948. In 1939 he was awarded ph.D. degree of the Bombay University. He was elected Associate of the Royal Institute of Chemistry in 1944, and the Associate of the Institute of Physics in 1946. In 1947 he was awarded the Junior fellowship of the National Institute of Sciences.

His work in Chemistry is of varied type. Along with measurements of dipole moments and dielectric constants of organic and inorganic salts, kinetics of chemical reactions, he carried out several syntheses in the anthelmintic series, the most important being the synthesis of santonin, Indian vegetable oils and fats, polymerisation of oils, and medicinal plants were also investigated. Thus, during the short period of 10 years, he was able to carry out work, which would have taken any other person twice the time considering the difficulties in obtaining chemicals and materials in a laboratory of limited means. He has published about 65 papers and left enough material for a dozen more.

Always of indifferent health, he suffered from Tuberculosis of lungs, during the last four years of his life. Even during this period he did not miss his attendance in the laboratory, and carried on his work with the same zest as in the earlier years of his life. He appeared to be cured in March 1948, but the disease took a wrong turn and he sank rapidly in June. During his last days he was engaged ironically enough in synthesising anti-tubercular compounds.

He had a prodigious memory and could cite pages and years of obscure references accurately at any time. Of a cheerful disposition, he was loved by all who came in contact with him.

—B. V. B. (POONA)

BOOKS RECEIVED

New Theory for the Strength of Wooden Box Beams, A, by J. R. M. Radok, J. P. O. Silverstein and H. A. Wells.

Publications of the Australian Council for Aeronautics, Commonwealth of Australia—

Observations of the Lubricating Oil Film Between Piston Ring and Cylinder of a Running Engine, by J. C. Wisdom and R. L. Brooks. Report No. 37.

Preliminary Analysis of a Highly Swept Cylindrical Tube Under Torsion and Bending, by W. H. Wittrick. Report No. 39.

Stability Derivatives Determination of I_p by free Rolling, by J. M. Evans and P. T. Fink. Report No. 35.

Vibration of Stationary and Rotating Propellers, by E. R. Love, J. P. O. Silverstein and J. R. M. Radok. Report No. 36.

Studies on Local Anesthetics—Xylocaine A New Synthetic Drug, by Nils Lofgren, Stockholm, 1948.

ACKNOWLEDGMENTS

Discovery
Ingenieria Quimica
Journal of Ayurveda
Journal of the India Society of Engineers
Manufacturing Chemist

Overseas Engineer
Psyche
Science Museum Library :
Monthly List of Accessions
Transactions of Chalmers University of Technology,

Journal

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[BIOLOGICAL SCIENCES, INCLUDING MEDICINE: NO. 25]

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THE CIRCULATORY SYSTEM OF *HYDROPHIS CAERULESCENS*, (SHAW).

BY D. V. BAL AND K. V. NAVATHE,

Department of Zoology,

The Royal Institute of Science, Bombay.

The Heart and the Aortic Arches

Fig. 1

THE heart of *Hydrophis caerulescens* is elongated and is situated at about one-third length of the animal from its anterior end. It is surrounded by the pericardium and consists of a sac-like sinus venosus, two thin-walled auricles and a thick-walled ventricle. The right auricle is considerably longer than the left as in other snakes.

The two aortic arches emerge from the base of the ventricle and pass forward ventral to the auricles. The left aortic arch arises from the right side of the ventricle and the right a little to the left of the former. The pulmonary arch starts from the right side of the ventricle and runs forward from dorsal to the aortic arches and then turns towards the lung.

(A) The Arteries in the Anterior one-third of the Body

Fig. 2

The right aortic arch gives off a common carotid artery (C.C.A.) which at a distance of about half an inch from its origin gives a short slender artery to the thyroid gland (Th. G.) This is the thyroidean artery (Th. A.) and has been considered by some comparative morphologists as the remnant of the right carotid artery. The common carotid artery proceeds forward on the left side of the neck as the left carotid artery (L.C.A.) and then bifurcates near the posterior extremity of skull into the left external (L.E.C.A.) and internal (L.I.C.A.) carotid arteries respectively. The former supplies the floor of the mouth and runs forward by the side of the sheath of the tongue (T.S.). Near the symphysis of the jaw it bends round the anterior part of the tongue as the labial artery (Lb. A.). The latter then continues posteriorly on the right side of the tongue, parallel to the left external carotid artery. It may therefore be called as the right external carotid artery (R.E.C.A.) and is connected with the left external carotid artery by short transverse branches. On reaching the posterior part of the skull, it gives off a fine branch, resembling the right internal carotid artery (R.I.C.A.), ending rather abruptly. It, like the corresponding vessel on the left side, supplies blood to the brain and the posterior part of the skull.

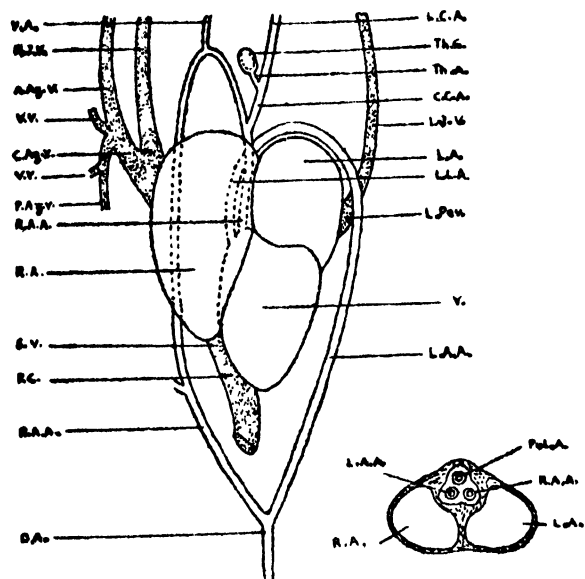


Fig. 1. The Ventral View of the Heart and the Associated Vessels

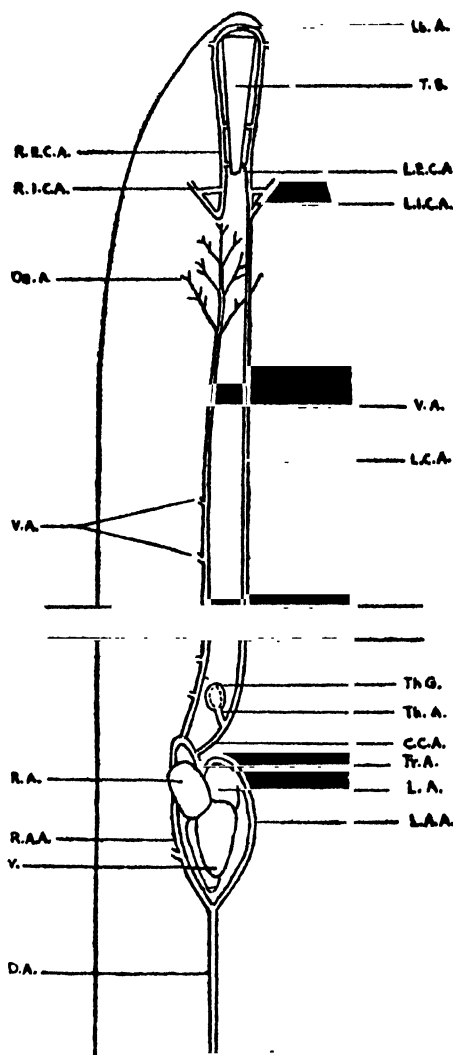


Fig. 2. Arteries in the Anterior one-third Region of the Body

After giving off the common carotid artery, the right aortic arch goes a little forward and then turns backwards. At the point where it turns, it gives off a big vertebral artery (V.A.) which lies ventral to the vertebral column and traverses the whole of the neck region upto the base of the skull. Towards the anterior end it becomes slender and finally breaks up into several fine branches (Oe.A.), supplying the oesophagus and the muscles in the anterior region of the neck. During its course, this vertebral artery also supplies blood to the vertebral column and the body muscles through a series of fine arteries varying from 16 to 24 in number.

The right aortic arch then proceeds further and meets the left aortic arch to form the dorsal aorta behind the heart. The left aortic arch is stouter than the right but does not give any branch.

In this snake as in *Echis carinata* (3), a secondary lung tissue is developed around the trachea in front of the heart and it is called the tracheal lung to distinguish it from the bronchial lung. The pulmonary circulation in these snakes is somewhat different from that found in snakes in which tracheal lung tissue is wanting. The pulmonary arch (Fig. 10. P.A.) emerges from the base of the ventricle and runs forward almost covered or hidden by the right and left aortic arches. On reaching the anterior part of the heart, it turns towards the lung and bifurcates into the anterior (Tr. A.) and posterior (Pul. A.) pulmonary arteries. They supply blood to the trachea and the lung respectively. For a short distance both these arteries run free from the trachea and the lung in which they finally break into capillaries.

(B) The Arteries in the Middle one-third of the Body

In this region the dorsal aorta supplies blood to the alimentary canal and its associated glands and also to the muscles and vertebrae as shown in Fig. 3. There are four gastric arteries of which the first (G.A.1) divides into two branches on reaching the stomach. The anterior of the two (A.G.A.) supplies blood to the mesentery, between the stomach (St.) and the liver (Li.) and the posterior (P.G.A.) to the stomach proper. The second, third and fourth gastric arteries (G.A.2-4) originate from the dorsal aorta one behind the other and branch on the stomach. Behind these is seen a big lienogastric artery (L.G.A.) which divides into the hepatic (H.A.), the gastric (G.A. 5) and the splenic (Sp. A.) arteries. Posterior to the lienogastric, the dorsal aorta gives rise to the superior mesenteric artery (S.M.A.). The latter branches into two vessels, the anterior of which is the pancreatic (pan. A.) and the posterior, the mesenteric (M.A.). All along this region the dorsal aorta gives origin to a number of vertebral arteries (V.A. 1-12) which supply the vertebral column and the muscles.

(C) The Arteries in the Posterior one-third of the Body

The arterial system in this region differs in the two sexes and is therefore described under two separate heads.

(a) *Arterial system in the male* (Fig. 4). After giving out a number of arteries to the gonads, kidneys, alimentary canal and vertebrae, the dorsal aorta becomes finer and finer towards the posterior extremity where it continues as the caudal artery into the tail.

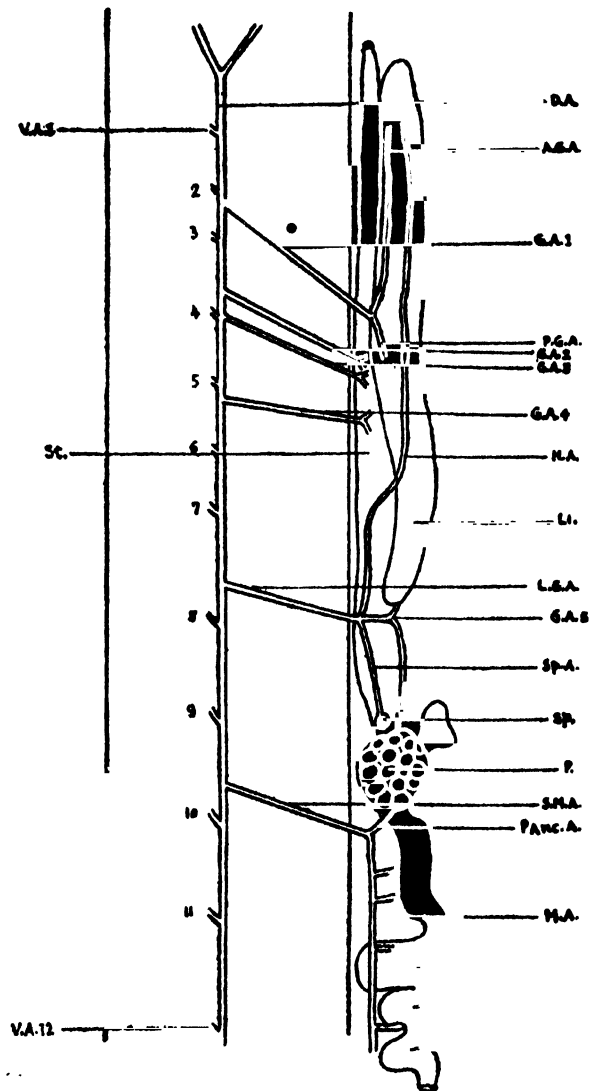


Fig. 3. Arteries in the Middle one-third Region of the Body

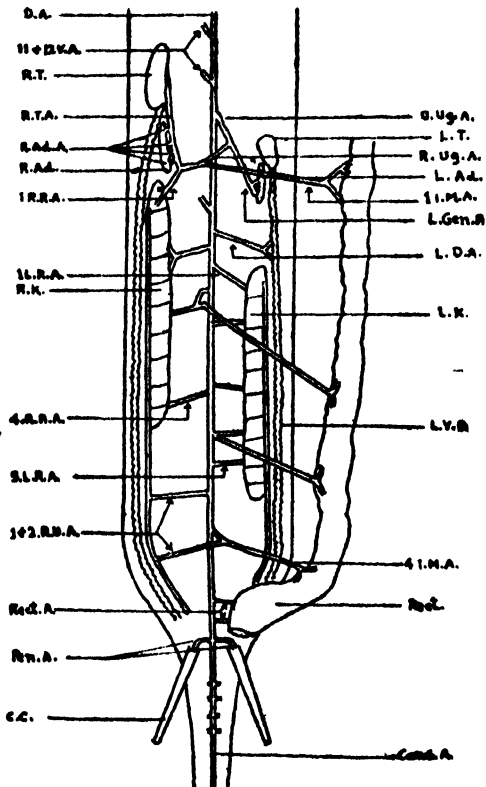


Fig. 4. Arteries of the Male in the Posterior one-third Region of the Body

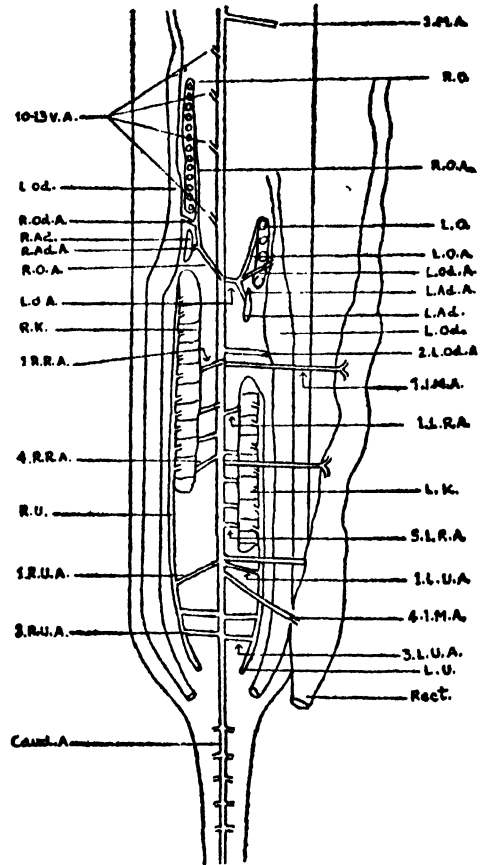


Fig. 5. Arteries of the Female in the Posterior one-third Region of the Body

An unpaired urinogenital artery (U.Ug.A.) arises from the dorsal aorta, a little behind the superior mesenteric artery and divides into right urinogenital artery (R.Ug.A.) and the left genital artery (L.Gen.A.). The right urinogenital artery gives out the first inferior mesenteric artery (1.I.M.A.) to the mesentery and then divides into two main branches. The anterior of them is the right spermatic artery (R.T.A.) and the posterior, the first right renal artery (1 R.R.A.). The former before reaching the testis sends out three to four adrenal arteries (R.Ad.A.) to the right adrenal body. The left genital artery supplies blood to the left adrenal body (L.Ad.) and the left testis (L.T.) only.

(b) *Arterial system in the female* (Fig. 5). There is no common urinogenital artery as in the male. In the female there are four right renal (R.R.A.) and five left renal (L.R.A.) arteries arising directly from the dorsal aorta. All the four inferior mesenteric arteries (I.M.A.) arise directly from the dorsal aorta unlike those in the male. The right (R.O.A.) and the left ovarian (L.O.A.) arteries arise from a common point on the dorsal aorta. Each ovarian artery also gives off a vessel to the oviduct (R. and L.Od.A.) and another to the adrenal (R. and L.Ad.A.).

The ureters are supplied with blood by three vessels (1,2,3, L.U.A. and 1,2,3, R.U.A.), arising from the dorsal aorta.

The Venous System

The venous system is better described in two parts, namely, the veins in the anterior one third of the body and those in the remaining region.

(A) The Veins in the Anterior one-third of the Body

Fig. 6

The veins in this region consist of the right and left precavals and the post-caval opening into the sinus venosus and the pulmonary vein opening into the left auricle. The right precaval is formed by two main veins—the right jugular and the common azygos. There is no azygos vein on the left side.

The jugular vein of each side near the posterior end of the skull is formed by two veins namely, the external jugular (R.E.J.V. & L.E.J.V.) and internal jugular (R.I.J.V. & L.I.J.V.). The internal jugular brings blood from the brain while the external jugular drains the lower jaw and the floor of the mouth. On its course the jugular vein of the right side receives a varying number of small vertebral veins (M.V.V.) from the neck region. Before opening into the right precaval this vein also receives a small thyroidean vein (Th. V.). After receiving these vessels, it empties into the right pre-caval along with the common azygos vein. The anterior azygos which is longer than the posterior commences half-way between the head and heart and receives small veins (M.V.V.) from the vertebral column and the adjoining tissues. It may be noted that the right jugular vein does not receive the minor vertebral veins behind the commencement of the anterior azygos vein. The posterior azygos vein brings blood from the vertebral column posterior to the heart and joins the anterior azygos

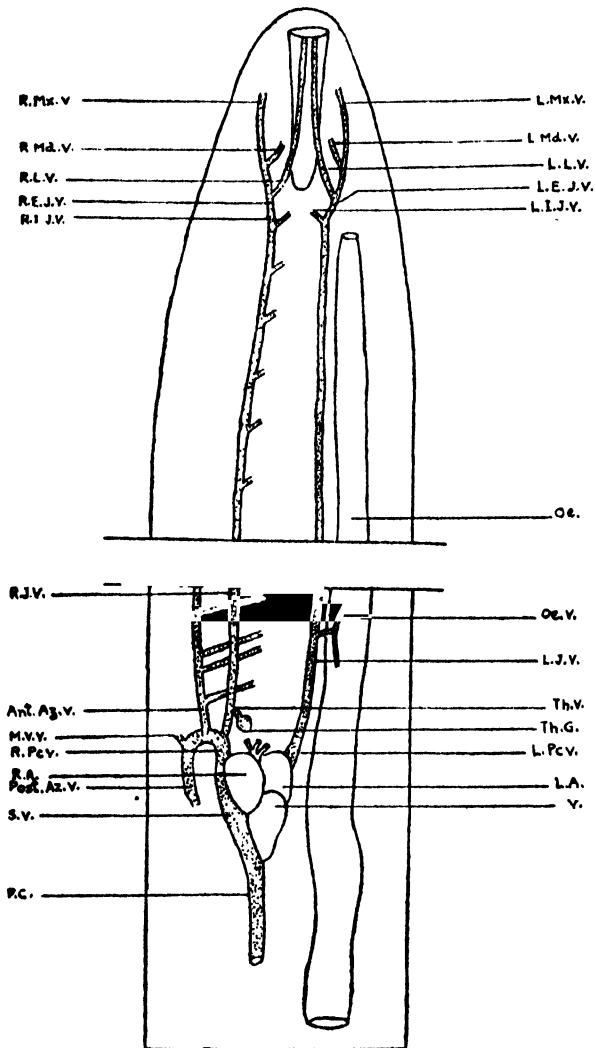


Fig. 6. Veins in the Anterior one-third Region of the Body

vein to form the common azygos vein (C. Az.V.). The left jugular vein receives one or two small oesophageal veins (Oe. V.) which are also present on the right side.

The blood from the trachea is drained by the anterior pulmonary vein (A.P.V. Fig. 10) which joins the posterior pulmonary vein (P.P.V.). The two veins join together to form a common vein which empties into the left auricle.

(B) The Veins in the Remaining two-third Region of the Body

Fig. 7

Here the venous system mainly consists of the post-caval, the renal and hepatic portal systems and associated vessels. The renal portal system in the two sexes is based on the same general plan but differs in some details as described below :—

The caudal vein (Caud. V.) is formed by a union of a number of small branches from the tail region. Just dorsal to the cloaca, it bifurcates into two vessels, the right and left renal portal veins (R.R.P.V. & L.R.P.V.). Each of them goes forward along the outer margin of the corresponding kidney between the vas-deferens and the ureter and branches in the substance of the kidney. Near the cloaca each renal portal vein sends a tributary (T) both of which open into a median rectal vein.

As the right kidney (R.K.) is placed anterior to the left (L.K.), the right renal portal vein is longer than the left. Posteriorly each renal portal vein receives a small vertebral vein (M.V.V.). The venous blood from each kidney is collected by many small vessels uniting into the renal vein (R.R.V. & L.R.V.). Each renal vein runs along the inner border of the kidney and receives some minute veins (R.U.V. & L.U.V.) from the corresponding ureter. In front of the kidneys the renal veins unite to form the post-caval vein (P.C.). The right renal vein before entering the post-caval receives two small right deferential veins (R.D.V.) from the vas deferens (R.V.D.) and one or two right adrenals (R.Ad.V.) from the posterior part of the adrenal gland (R.Ad.). The left renal (L.R.V.) receives two deferentials (L.D.V.), four adrenals (L.Ad.V.) and a spermatic vein (L.T.V.). The post-caval vein at its commencement receives three small adrenals (3 R.Ad.V.) from the anterior part of the right adrenal gland and spermatic vein (R.T.V.) from the right testis.

The post-caval then runs towards the heart and on its way receives about six hepatic veins (H.V.) from the liver and two from the body wall (B.V.), as shown in Fig. 10. The post-caval finally opens in the sinus venosus.

In the female the right renal vein (Fig. 8. R.R.V.) after emerging from the right kidney receives two short oviducal veins (R.Od.V.) from the oviduct (R.Od.) and an adrenal (R.Ad.V.) from the posterior part of the right adrenal gland. While the renal vein on the left side (L.R.V.) receives three oviducal and four adrenal veins. A vertebral vein (M.V.V.) opens on the inner side into the left renal vein. A corresponding vein is absent on the right side.

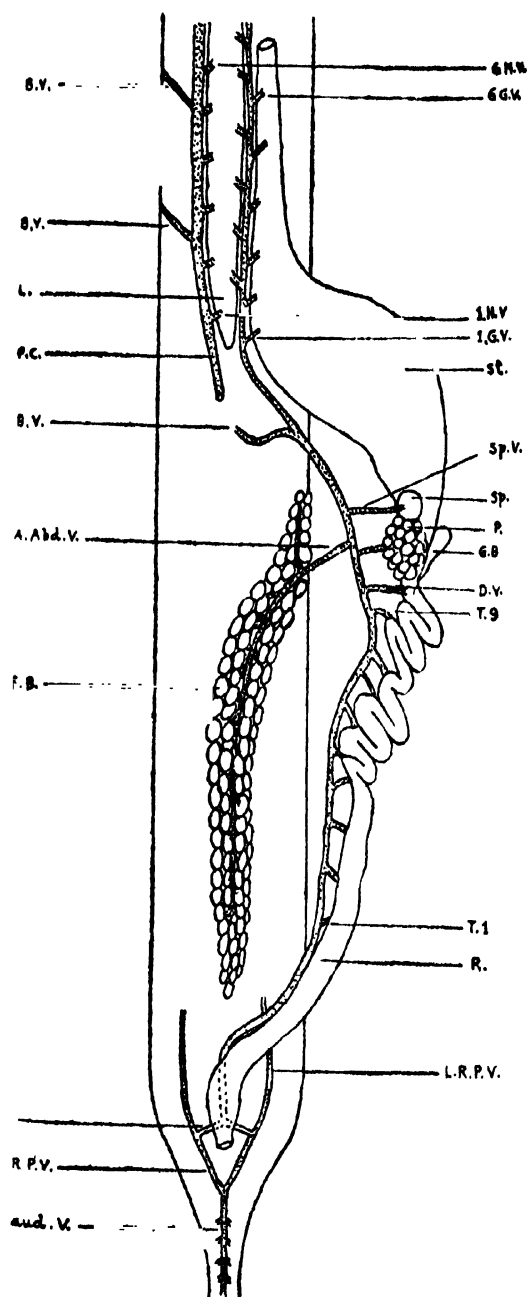


Fig. 9. Hepatic Portal System

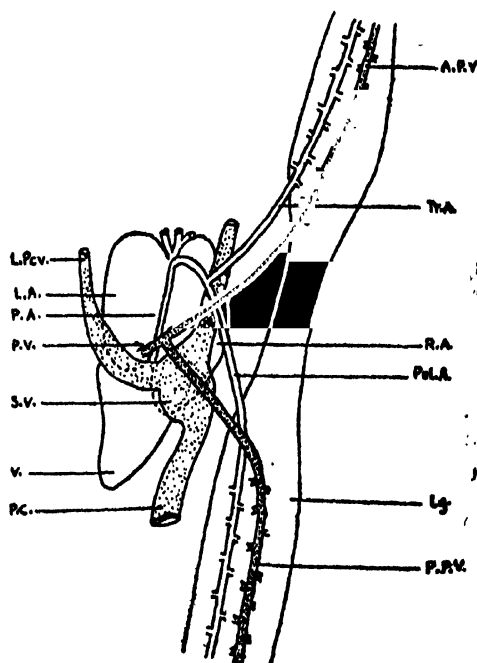


Fig. 10. Pulmonary Circulation

Just at the junction of the two renal veins a short ovarian vein (L.O.V.) from the left ovary (L.O.) opens in the post-caval vein. The latter receives four short adrenals (4. R.Ad.V.) from the anterior part of the right adrenal gland and two ovarian veins (R.O.V.) from the right ovary. Beyond this the post-caval receives veins as in the male before it opens in the sinus venosus.

As stated previously the hepatic portal vein (Fig. 9. H.P.V.) receives at its commencement a pair of small connectives from the renal portal veins. Throughout its course it runs along the dorsal side of the digestive tube and receives several short vessels (T_1, T_2, T_3 , etc.). A varying number of intestinal veins open into the hepatic portal at different levels. Beyond the region of the intestine a vein from the pancreas (Pn.V.) conveys blood from that organ into the portal circulation. A little anterior to the opening of the pancreatic vein a conspicuous vein (A.Abd.V.) from the fat body drains into it. This vein from the fat body is regarded as the homologue of the anterior abdominal vein. A short vein (Sp.V.) from the spleen also joins it.

In front of the splenic vein the hepatic portal vein receives a large vein (B.V.) from the body wall and then runs forward between the liver and the stomach. On its course, it is joined by a number of gastric veins (1-6 G.V.). The post-caval lies on the dorsal side and the hepatic portal on the ventral side of the liver. The hepatic portal vein eventually terminates by giving off many branches to the liver.

BIBLIOGRAPHY

- 1) Connant and Bridges : What Snake is that ? D. Appleton Century Company, London, 1939.
- 2) Ditmars : Snakes of the World. The Macmillon, New York, 1937.
- 3) George, C. J. & Varde, (Miss) M. R. : A note on the modification of the lung and the trachea in some Indian Snakes. *J. Univ. Bombay*, 10 (3), 1941.
- 4) Gharpurey K. G. : The Snakes of India, Bombay, 1937.
- 5) Mathur P. N. : Proc. Ind. Acad. Sci., Vol. XXIII, No. 3, March 1946.
- 6) Saunders & Manton : A Manual of Practical Vertebrate Morphology. Oxford University Press, London, 1931.
- 7) Smith M. A. : Fauna of British India, Reptilia & Amphibia, Vol. III, London, 1943.
- 8) Wall F. : A Monograph of the Sea Snakes. The Asiatic Society, Calcutta, 1909.

ABBREVIATIONS

A. Abd. V.	= Anterior abdominal vein.
A. Az. V.	= Anterior azygos vein.
A. G. A.	= Anterior gastric artery.
A. P. A.	= Anterior pulmonary artery.
A. P. V.	= Anterior pulmonary vein.
B. V.	= Veins from the body wall.
Caud. A.	= Caudal artery.
Caud. V.	= Caudal vein.

ABBREVIATIONS—(continued)

C. Az. V.	= Common azygos vein.
C. C.	= Corpora cavernosa.
C. C. A.	= Common carotid artery.
D.	= Duodenum.
D. A.	= Dorsal aorta.
D. V.	= Duodenal vein.
F. B.	= Fat body.
G. A.	= Gastric artery.
1-4 G. A.	= First to fourth Gastric arteries.
1-6 G. V.	= First to sixth Gastric veins.
H. A.	= Hepatic artery.
H. P. V.	= Hepatic portal vein.
H. V.	= Hepatic vein.
1-6 H. V.	= First to sixth Hepatic veins.
1-4 I. M. A.	= First to fourth Inferior mesenteric arteries.
Int.	= Intestine.
L.	= Liver.
L. A.	= Left auricle.
L. A. A.	= Left aortic arch.
L. Ad.	= Left adrenal gland.
L. Ad. A.	= Left adrenal artery.
L. Ad. V.	= Left adrenal vein.
Lb. A.	= Labial artery.
L. C. A.	= Left carotid artery.
L. D. A.	= Left deferential artery.
L. D. V.	= Left deferential vein.
L. E. C. A.	= Left external carotid artery.
L. E. J. V.	= Left external jugular vein.
Lg.	= Lung.
L. Gen. A.	= Left genital artery.
L. G. A.	= Lienogastric artery.
L. I. C. A.	= Left internal carotid artery.
L. I. J. V.	= Left internal jugular vein.
L. J. V.	= Left jugular vein.
L. K.	= Left kidney.
L. L. V.	= Left lingual vein.
L. Md. V.	= Left mandibular vein.
L. Mx. V.	= Left maxillary vein.
L. O.	= Left ovary.
L. O. A.	= Left ovarian artery.
L. Od.	= Left oviduct.
L. Od. A.	= Left oviducal artery.
2 L. Od. A.	= Second left oviducal artery.
L. O. V.	= Left ovarian vein.
L. Od. V.	= Left oviducal vein.
L. Pcv.	= Left precaval vein.
1-5 L. R. A.	= First to fifth left Renal arteries.
L. R. P. V.	= Left renal portal vein.
L. R. V.	= Left renal vein.
L. T.	= Left testis.
L. T. V.	= Left spermatic vein.
L. U.	= Left ureter.
1-3 L. U. A.	= First to third Arteries to the left ureter.
L. U. V.	= Vein from the left ureter.
L. V. D.	= Left vas deferens.
M. A.	= Mesenteric artery.
M. V. A.	= Minor vertebral artery.
1-13 M. V. A.	= First to thirteenth minor vertebral arteries.
M. V. V.	= Minor vertebral vein.
Oe.	= Oesophagus.
Oe. A.	= Oesophageal arteries.
Oe. V.	= Oesophageal vein.
P.	= Pancreas.
P. A.	= Pulmonary artery.
Panc. A.	= Pancreatic artery.
Pen. A.	= Penial artery.

ABBREVIATIONS—(continued)

Pn. V.	=	Pancreatic vein.
P. Az. V.	=	Posterior azygos vein.
P. C.	=	Post caval vein.
P. G. A.	=	Posterior gastric artery.
P. P. A.	=	Posterior pulmonary artery.
P. P. V.	=	Posterior pulmonary vein.
P. V.	=	Pulmonary vein.
R. or. Rect.	=	Rectum.
R. A.	=	Right auricle.
R. A. A.	=	Right aortic arch.
R. Ad.	=	Right adrenal gland.
R. Ad. A.	=	Right adrenal artery.
R. Ad. V.	=	Right adrenal vein.
3-4 R. Ad. V.	=	Three and four right adrenal veins.
R. D. V.	=	Right deferential vein.
R. E. C. A.	=	Right external carotid artery.
Rect. A.	=	Rectal artery.
R. E. J. V.	=	Right external jugular vein.
R. I. C. A.	=	Right internal carotid artery.
R. I. J. V.	=	Right internal jugular vein.
R. J. V.	=	Right jugular vein.
R. K.	=	Right kidney.
R. L. V.	=	Right lingual vein.
R. Md. V.	=	Right mandibular vein.
R. Mx. V.	=	Right maxillary vein.
R. O.	=	Right ovary.
R. O. A.	=	Right ovarian artery.
R. Od.	=	Right oviduct.
R. Od. A.	=	Right oviducal artery.
R. Od. V.	=	Right oviducal vein.
R. O. V.	=	Right ovarian vein.
R. Pcv.	=	Right precaval vein.
R. R. P. V.	=	Right renal portal vein.
1-4 R. R. A.	=	First to fourth right renal arteries.
R. R. V.	=	Right renal vein.
R. T.	=	Right testis.
R. T. A.	=	Right spermatic artery.
R. T. V.	=	Right spermatic vein.
R. V. D.	=	Right vas deferens
R. U.	=	Right ureter.
1-3 R. U. A.	=	First to third arteries to the right ureter.
R. U. V.	=	Vein from the right ureter.
R. Ug. A.	=	Right urinogenital artery.
Sp.	=	Spleen.
S. M. A.	=	Superior mesenteric artery.
Sp. A.	=	Splenic artery.
Sp. V.	=	Splenic vein.
St.	=	Stomach.
S. V.	=	Sinus venosus.
T.	=	Tributaries connecting the renal portal and the hepatic portal systems.
T ₁ to T ₉	=	First to the ninth tributaries from the stomach.
Th. A.	=	Thyroidean artery.
Th. G.	=	Thyroid gland.
Th. V.	=	Thyroidean vein.
Tr.	=	Trachea.
Tr. A.	=	Anterior pulmonary artery.
T. S.	=	Sheath of the tongue.
U. Ug. A.	=	Unpaired urinogenital artery.
V.	=	Ventricle.
V. A.	=	Vertebral artery.

A CONTRIBUTION TO THE STUDY OF THE ROOT HABITS AND ANATOMY OF INDIAN PLANTS

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(Continued from Vol. XVII, Part 3, p. 60)

PART II

Ixora alba Linn.

I. *General Remarks and External Features*.—This is a small, much branched, evergreen tree, smooth in every part and bearing white long-tubed flowers in dense compound or decomposed, often hemispheric corymbs. It is found in gardens. The main tree has an extensive development of horizontally spreading root-runners which produce a large number of daughter shoots by means of root-suckers, giving the characteristic gregarious aspect to the plant. An examination of the ground in the immediate vicinity of the plant reveals that the daughter shoots do not become disconnected but are dependent throughout life, to some extent at least, upon the assimilatory activities of the parent shoot and of one another. Plate F. shows a part of this colony produced from the parent shoot.

II. *Internal Structure*.—(Figs. 42-54). Root runners and their branches were examined anatomically. Very young roots showing the primary vascular tissues could not be obtained. In older roots, due to secondary wood development and strong lignification of the pith, the identity of the primary vascular tissues is lost.

A transverse section of a rather young root shows a superficial layer of tabular cells some of which are seen to be produced into root hairs. There is a single layered hypodermis of larger, somewhat radially elongated rectangular cells. Then follows a parenchymatous cortex of 10-12 layers of rounded, oval or irregular-shaped thinwalled cells with intercellular spaces. Yellowish contents are evident here and there in the cortical cells. The endodermal cells are elongated somewhat tangentially and they can be easily distinguished from the much larger, radially elongated, clearer cells of the pericycle within. In older roots the pericyclic cells are seen early to divide tangentially so as to cut off at first centripetally, a mass of phelloderm tissue. Later on, a few layers of thickwalled phellem are cut off centrifugally and the endodermis and the primary tissues outside it die off. The phelloderm is considerable relative to the phellem of which there is slight development. It is made up of rounded or oval thinwalled cells. Isolated, heavily lignified cells may be seen in the phelloderm which is abundantly packed with starch

grains and globular contents. The secondary phloem is slightly developed. Rhombohedral crystals of calcium oxalate occur in the phloem. The wood is diffuse porous and together with the heavily lignified pith forms a solid woody cylinder. The secondary xylem is characterised by small vessels evenly distributed and often occluded with brownish contents. The majority of the vessels are solitary or radially paired or occasionally in groups of 3-5, fairly close and embedded in fibrous tracts. Parenchymatous elements are meagre. Wood fibres are not definitely aligned in radial rows. Numerous uni-or biseriate wood rays, packed with starch grains traverse the woody cylinder. The pith is composed of heterogenous elements, thicker walled cells with extremely small lumina being distributed among less thickwalled elements. Starch grains and globules, possibly of oil, occur in the pith.

The strongly developed vascular cylinder especially in the root runner ensures the conduction that is necessary for the maintenance of the numerous daughter shoots which are dependent to some extent upon the mother shoot. Also, there is an elaborate provision for storage of superfluous plastic materials in the massive phelloderm and wood rays which would be invaluable for the growth of the colony as a whole.

Carissa Carandas Linn.

I. *General Remarks and External Features.*—This is a large ever-green shrub with a short stem armed with twin, stout short horizontal spines. It is distributed throughout India and occurs in the Bombay Presidency, in the Konkan, Deccan, North Kanara and the Ghats. The root system consists of a cylindrical tapering tap-root with a few slender laterals (Pl. G).

II. *Internal Structure.*—(Figs. 55-62). A tranverse section of an old root reveals a many layered phellem which appears concentrically stratified due to differential thickenings and impregnation of the tangential walls of cells of some rows, which alternate with rows of thin-walled cells. The cells are mostly rectangular with somewhat wavy radial walls. Greyish contents occur in some of the cells (latex?). There appears to be no phelloderm formed. The phellogen is in direct contact, on the inner side, with the phloem masses and together with the phellem products follows the wavy contours of the phloem. It would appear from this, that the phellogen arises from some layer of the phloem or immediately outside it. The outer phloem is composed of large oval or rounded cells aligned in radial rows (phloem parenchyma). Large secretory canals holding sticky mucilage occur in this region. The inner phloem is characterised by smaller sieve tissue elements and phloem parenchyma holding starch grains and crystal idioblasts. Small secretory canals occur in the inner phloem. Large groups of isolated stone cells whose lumina are blocked with yellow contents are seen in the phloem. Uniseriate phloem rays are filled with starch grains. The wood is diffuse porous with moderate-sized vessels, usually solitary or rarely in radial rows, open or plugged with deposits of yellowish gum. Contiguous wood rays are seen on one, rarely on both sides. Parenchyma is extremely meagre, the greater mass of wood being composed of fibres aligned in radial rows and of irregular shape. Wood rays, usually uni- rarely biseriate hold abundant starch grains. The

primary xylem elements are not easily distinguishable. The pith is made up of thickwalled lignified cells and together with the xylem forms a solid woody mass. Starch grains and yellowish gummy contents frequently occur in the pith.

Lantana Camara Linn.

I. *General Remarks and External Features*.—It is an evergreen straggling shrub with recurved prickles on the stems, branches and leaves with a strong odour of black currants when crushed. It is a native of tropical America and has run wild in many parts of India. The plant is shallow rooted consisting of a cylindrical tapering tap root with a large number of slender branched laterals arising near the base of the tap root and running somewhat horizontally. A few laterals also emerge near the apex of the tap root. (Pl. H.).

II. *Internal Structure*.—(Figs. 63-68). A transverse section of a root reveals a wide periderm deep-seated in origin. The phellem cells are thinwalled, rectangular and filled with yellow granular contents. On the inner side of the phellem is a parenchymatous tissue of oval or rounded cells which, it is difficult to say whether it is phelloderm alone, or primary cortex and phelloderm. At any rate, it appears that the phellogen arises outside the phloem. The phloem calls for no special comment. The number of primary xylem bundles could not be easily detected. The wood is diffuse porous with vessels either solitary, occasionally paired radially, or in groups of 3-5, fairly close and evenly distributed with contiguous rays on one or both sides. Parenchyma is extremely sparse, the greater mass of wood being composed of wood fibres aligned in radial rows. Wood rays, usually uni-or biseriate and holding a few starch grains traverse the woody mass. A pith when present, is composed of thickwalled lignified cells often indistinguishable from the rest of the woody elements and forms, together with the latter, a solid woody cylinder. Certain sections of the roots revealed a core of balloon-shaped thinwalled parenchymatous cells in the sclerosed pith.

Vitex Negundo Linn.

I. *General Remarks and External Features*.—This plant has been described as a deciduous shrub (88) but as far as the present writers' observations go, it is always found in foliage throughout the year. It is common throughout the Presidency and in India. It is abundant in open waste places and as a hedge plant along roads and fields.

II. *Internal Structure*.—(Photo XI ; Figs. 69-72). A cross section of a root reveals a wide band of periderm composed of thickwalled phellem cells having irregular outlines and varying in size and shape so that the bark comes off in irregular ragged masses. The phellogen giving rise to the phellem is formed from a layer of cells immediately outside the pericycle. Cell aggregations, more or less radially disposed and having yellow contents, are seen in the phellem. The pericycle consists for the most part of ragged tangential bands of stone cells and parenchyma. The phloem forms a relatively narrow zone and calls for no special comment. No starch grains were observed in the phloem or its rays. The wood is radially diffuse porous with medium sized

vessels more or less evenly distributed and arranged in a radial series. The majority are either solitary or radially paired, and embedded in heavy fibrous tracts, occasionally with contiguous rays on one or both sides or without them. The parenchyma is extremely meagre. The greater bulk of the wood consists of fibres, aligned in radial rows. Wood rays, usually bi-triseriate consists of somewhat lignified, thickwalled cells holding starch grains. The pith becomes sclerosed and together with the wood forms a solid woody cylinder.

Careya arborea Roxb.

I. *General Remarks and External Features.*—It is a middle-sized to large, deciduous tree with large ovate leaves clustered at the ends of branches. It occurs throughout the Bombay Presidency in the deciduous forest and is distributed throughout India and Ceylon (25). It is found growing in moist localities, in ravines and valleys and sometimes scattered in grasslands (64). The root system consists of a long, tapering tap root with numerous branching laterals concentrated for the most part near the surface of the soil (Pl. I).

II. *Internal Structures.*—(Photo XII ; Figs. 73-81). Transverse sections of old roots were examined. There is a thin strip of periderm abutting against the phloem zone. The phellem consists of 3-6 layers of thinwalled rectangular cells blocked with brownish contents. There is no indication of the formation of a phelloderm. As the phellogen directly abuts upon the phloem fibres it would appear that it has its origin in the pericycle or in the phloem itself. The phloem is a broad zone composed of alternate bands of sieve tissue elements and phloem fibres arranged in radial series and separated by phloem rays which expand centrifugally. The sieve tissue elements may be recognised in the younger parts of the phloem near the cambium but peripherally they undergo conversion into starch laden parenchyma and together with the phloem rays which are heavily charged with starch they constitute an important storage tissue. The phloem rays may be readily recognised by dark brown contents in many of its cells. The stele is 7-arch. The wood is radially diffuse porous, with vessels either solitary or in radial rows of 2-5 with contiguous rays on one or both sides. The vessels are small and often occluded with brown gummy contents. There is a slight disposition into annual rings caused by concentric bands of zonate parenchyma. Paratracheal parenchyma is confined to the immediate vicinity of the vessels or vessel groups and generally connects the vessels laterally with the wood rays. It is often interrupted by fibres contiguous to the vessels. Matatracheal parenchyma is very abundant and scattered. For the most part it is disposed in uniseriate concentric lines separated by rows of fibres and forms a fine reticulum with the wood rays. Wood fibres are small, angled and not aligned in radial rows forming tangential bands alternating with narrow lines of parenchyma and crossed by wood rays. Wood rays, mostly unitriseriate, packed with starch grains traverse the woody mass. The stellate condition of the primary xylem bundles, each composed of 4-5 contiguous, tangentially paired elements, is quite apparent. The pith is composed of heterogenous elements, viz. thinwalled unlignified cells holding starch grains and thickwalled lignified cells. Brown contents are rather frequent in the cells of the pith.

Vangueria spinosa Roxb.

I. *General Remarks and External Features.*—It is a large deciduous shrub or small tree with straight, opposite, somewhat sharp spines. It is pretty common in India and in the Bombay Presidency occurs on the Ghats, in the Deccan, the Southern Maharatta country and Kanara (25).

II. *Internal Structure.*—(Photos XIII, XIV). In the transverse section of the young root, the superficial layer consists of a single row of wedge-shaped cells having their inner tangential and part of the radial walls slightly thickened and coloured reddish brown (suberised). Some of the cells are produced into root hairs. Beneath this layer is a hypodermis of polygonal, somewhat radially elongated cells. The cortex is composed of 10-12 layers of rounded, oval or irregular-shaped polygonal cells with intercellular spaces. Cells with golden brown contents are distributed here and there in the cortex. Acicular raphides of calcium oxalate and a few starch grains occur occasionally in the cortex. The endodermis is a single layer of oblong cells which resemble the cortical cells except that they are tangentially elongated. A single row of still smaller thinwalled cells represents the pericycle. The stele is hexarch. The vascular cylinder shows a large, hexagonal mass of wood with slightly concave sides at the centre surrounded by a continuous zone of phloem, the outer limit of which, opposite to each side of the hexagonal mass is seen to be marked by isolated phloem fibre strands. The secondary xylem is characterised by vessels with narrow lumina embedded within a compact tissue of wood fibres and, as the pith is also thickwalled and heavily lignified, the central mass of wood appears solid. Starch occurs in some of the thickwalled cells of the wood.

In older roots examined, the outer cortical layers are seen to be completely sloughed off by the formation of undulating bands of phellem so as to make the roots appear to be alternately ridged and furrowed in transverse section. The periderm is deep-seated. Sections show that the phellogens are formed successively deeper and deeper in the phloem so that masses of phloem tissue including the phloem fibres are cut off. The secondary phloem in older roots shows almost continuous tangential bands of sieve tissue elements and phloem parenchyma alternating with ragged bands of phloem fibres arranged concentrically. Raphides, rhombohedral crystals of calcium oxalate and coloured contents characterise the phloem. Phloem rays broaden out distally and are packed with starch. The secondary xylem is characterised by moderate sized vessels, evenly distributed, often occluded with pale yellow gummy contents, frequently with contiguous rays, solitary for the most part or radially paired in the radial or tangential plan. Paratracheal parenchyma is sparse and confined to the immediate vicinity of the vessels or interrupted by fibres contiguous to the vessels with cells peripherally flattened. Metatracheal parenchyma is somewhat abundant and scattered. Starch grains and gummy brown contents are occasional in the parenchymatous elements. Wood fibres are numerous with heavily lignified walls and often with completely obliterated lumina. Numerous bi-triseriate wood rays, packed with starch grains traverse the woody cylinder. The pith is composed of thickwalled, lignified polygonal cells which hold starch grains and brown contents. Fibres with narrow lumina are also present.

Bridelia retusa Spreng.

I. *General Remarks and External Features*.—This is a small or moderate sized deciduous tree with variable coriaceous leaves having straight parallel lateral veins. Young trees are often covered with strong thorns which are of the nature of "root thorns" occurring in *Acanthorhiza* (33), *Iriarteia* (33), *Dioscorea prehensilis* (33, 39), *Moraea* (33), *Myrmecodia* (33) and *Bridelia pubescens* (62). The underground root system in a young plant consists of a tap root, moderately long, thick, cylindrical and tapering with long fibrous laterals. In all the plants examined the tap root showed a tendency to compression at the base where it passed into the stem by forming a knee-shaped bend (Pl. J).

II. *Internal Structure*.—(Photo XV; Figs. 82-84). Anatomical study of the root thorn of *Bridelia pubescens* Kurz. has been made by Parija and Misra (62). The present writers have confined their observations to the underground roots of *Bridelia retusa* Spreng. A transverse section of the root shows a periderm which is deep-seated in origin and abuts on the phloem. It consists of 5-7 layers of rectangular phellem cells heavily suberised and with the tangential walls thickened. The phloem consists of sieve tissue elements and phloem parenchyma alternating with tangentially elongated bands of phloem fibres which are often associated with crystal idioblasts. The phloem fibre has a characteristic structure. Its walls show differentiation into an outer portion which becomes stained with saffranin and an inner, clear refractive one which by its thickness often tends to obliterate the lumen of the fibre. Phloem rays slightly broaden out centrifugally. The stele is triarch. The wood is radially diffuse porous. The secondary xylem is made up of large vessels solitary or arranged in radial rows of 3-5, occasionally with contiguous rays on one or both sides. Parenchyma is sparse and shows a tendency to be arranged in zones so as to give a faint appearance of growth rings. The wood is mainly composed of wood fibres aligned in radial rows with elements having the characteristic cell wall thickening seen in the phloem fibres. Numerous wood rays, usually uni-, rarely biseriate, heavily packed with starch grains, often associated with golden brown contents, radiate through the mass.

Leca sambucina Willd.

I. *General Remarks and External Features*.—It is a perennial evergreen shrub, up to 3 m. high with the aerial shoots arising from a somewhat woody shortened subterranean stem which bears tufts of adventitious roots (Pl. K.). The latter are of two kinds, viz. (1) white slender flexible roots (*a*) and (2) fusiform tuberous roots (*b*). Both types give off a few laterals (*c*). The plant is widely distributed throughout the Bombay Presidency occurring in the Western Ghats, Konkan, Ghat jungles and in the Deccan.

II. *Internal Structure*.—(Photos XVI, XVII; Figs. 85-97). A transverse section of a slender adventitious root (Photo XVI; Fig. 85) shows, in the younger parts, a piliferous layer of more or less tabular cells which soon become suberised in the older parts. No phellem derived from a phellogen has been observed in these roots. Beneath

the piliferous layer is a cortex composed of rounded or oval thinwalled parenchymatous cells with intercellular spaces. Cells with slightly lignified walls occur sparsely in the cortex. The endodermis forms an undulating ring giving the stele a fluted appearance. The endodermal cells are irregular shaped and filled with black contents. The pericycle is thinwalled and holds dense black contents. The stele is 10-arch. The xylem masses which occupy the ridges of the fluted column are more or less T-or Y-shaped. The vertical stroke of the T or Y being represented by the small protoxylem elements and the arms of the Y or the horizontal stroke of the T, as the case may be, is made up of 3 larger metaxylem elements, more or less polygonal in outline. Tyloses with brown contents occasionally occur. Wood fibres and parenchyma are abundant. The pith constitutes the main bulk of the root. It consists of irregular-shaped cells with intercellular spaces. Cells with starch grains, blackish contents, tannin and acicular raphides frequently occur in the parenchymatous tissues.

A transverse section of the fleshy tuberous root (Photo XVII ; Figs. 86-93) shows the following features :—There is a well developed periderm deep-seated in origin. It consists of thinwalled rectangular phellem cells with straight outlines and blocked with dark brown contents (tannin). As the endodermis and primary cortex are not seen, it is evident that these layers are outside the periderm and have been rubbed off and that consequently the phellogen arises on the inner side of the endodermis. The rather broad zone of oval or rounded cells with intercellular spaces lying between the phellem and phloem masses is the phelloderm. Rounded lignified cells occur in this tissue. The stele is either diarch or triarch, with the primary xylem plates meeting in the centre or there is some amount of pith. The secondary xylem masses are situated outside the primary xylem plates and in positions alternating with them and separated from one another by primary wood rays which extend outwards from the protoxylem elements. At the extreme tip of the tuber, the wood is for the most part compact and radially diffuse porous. The vessels are large, solitary or as many as 2-6 contiguous in the radial plane. Wood fibres and wood parenchyma, the former predominating, are aligned in radial rows and are frequently filled with dark brown contents. The phloem masses are characterised by sieve tissue elements and phloem parenchyma. Druses of calcium oxalate and dark brown contents occur in the phloem rays.

In the tuberous part of the root, a pith-like mass is seen in the centre. This mass expands and increases in diameter by the division of its cells ("dilatation parenchyma"). Change in the mode of activity of the cambium results in the production of greater masses of unlignified parenchyma, radially aligned, in place of lignified elements, which latter are reduced to narrow, radial peripheral wedged shaped strips or small islands embedded in the parenchymatous ground tissue. Failure in lignification of potential xylem cells causes the metaxylem areas to be broken up and separated from the primary xylem elements so that the latter occur as island groups in the central mass of parenchyma. Tyloses are abundant and often hold brown (tannin) contents. The parenchyma for the most part, forms a massive storage tissue. The dominant ergastic product is starch. Cells containing tannin and mucilage sometimes associated with raphides occur here and there.

In the proximal part of the root there is greater amount of lignified tissue with larger vessels than in the tuberous part. The pith is considerably reduced and surrounded by a narrow zone of solid wood. The peripheral strips are more massive and more heavily lignified than in the tuberous part.

A transverse section of a lateral root (Figs. 94-96) shows a piliferous layer of more or less tabular cells. There is a parenchymatous cortex of rounded or oval cells with intercellular spaces. The endodermis is a well defined layer consisting of large cells with irregular outlines. The stele is 5-arch. The xylem masses are radially contiguous or T- or Y-shaped as in the slender adventitious root. A large pith is present. Secondary growth takes place in the usual way. Periderm formation is slight. The endodermis is persistent and conspicuous by its well defined cells. The wood is radially diffuse porous. Wood fibres and wood parenchyma are present.

From the above observations it will be seen that the roots are heterarchic (Figs. 97). The slender flexible adventitious roots are poly-arch, the xylem and phloem strands ranging up to 10 each. The tuberous roots are either diarch or triarch, whereas the slender laterals coming off from the tuberous roots may be as many as 6 arch. Heterarchic roots have been reported in various plants by De Bary (7) and Majumdar (54). The view here held in regard to the heterarchic roots of *Leea sambucina* is not inconsistent with the conclusions arrived at by Liese (52) that in any particular species the greater the number of primary xylem bundles the greater would be the abundance of rootlets and therefore the potential absorptive surface of the juvenile root system. But in the cases recorded so far it appears that size is a factor determining the number of vascular strands, the thicker roots having more strands than the thinner. In *Leea sambucina* however, the number of strands is in inverse relation to size. It would appear that in this case the number of strands has some relationship to the potentiality of these roots for tuberisation, roots with fewer number of strands becoming more readily tuberous than those in which the strands are in greater number. The intermediate number of strands, viz. 5, in the slender laterals of the tuberous root seem to suggest that these roots have still some potentiality left for tuberisation. The larger number of strands in the slender flexible roots and laterals as compared with the tuberous roots is indicative of the relative roles of these roots in regard to conduction.

Datura fastuosa Linn.

I. *General Remarks and External Features*.—Although *Datura* has been described as an annual in the Floras this plant is not an annual. It is common on rubbish heaps throughout the Bombay Presidency and can be readily recognised by its large, white or cream coloured, trumpet-shaped flowers which are as much as 7 in. long (25). It has a persistent tap root with numerous slender, finely remifying laterals (Pl. L.) The colour of the roots is silvery white.

II. *Internal Structure*.—(Photo XVIII; Figs. 98-102). The transverse section of a tap root shows a massive periderm composed of irregular squarish phellem cells developed from a phellogen deeply placed in

the cortex. Here and there on the periphery of the periderm may be seen small masses of the disintegrating primary tissues. Beneath the phellem and radially continuous with it are a few layers of more or less oblong or oval cells with intercellular spaces. These constitute the phelloderm. On the inner side of the phelloderm is a narrow zone of other similar slightly smaller cells whose outer layers appear to be crushed. This, from its position with reference to the pericyclic fibrous strands is to be regarded as the remnant of the primary cortex. As there is no distinct endodermis to demarcate it from the pericycle, the latter tissue appears to be continuous with the primary cortex. But the position and extent of the pericycle can be more or less made out by the distribution of the pericyclic fibres occurring singly or in groups in the mass of tissue outside the phloem. Starch grains, druses of calcium oxalate and calcium sand are distributed in the parenchymatous tissues. The stele is tetrarch. The secondary xylem is characterised by numerous rounded vessels, solitary and tangentially paired, occasionally in groups of 3-4, embedded in compact tissue mostly of fibres and together with the latter forming irregular, often island masses separated by corresponding masses of unlignified thinwalled parenchyma from which the wood rays are indistinguishable. The main bulk of the root is composed of parenchymatous tissue packed with starch and also containing druses of calcium oxalate and calcium sand pointing to the obvious role of the root as a storage organ.

The transverse section of a lateral root shows a massive periderm composed of rectangular, tangentially flattened thinwalled phellem cells placed in regular rows. The close proximity of the phellem cells to the pericyclic fibrous strands with only 1-2 rows of parenchymatous cells intervening, suggests that the phellogen producing the phellem is derived from the parenchyma of the primary cortex abutting on the pericycle and scarcely, if at all, any phelloderm is produced. The stele is tetrarch. The secondary xylem is characterised by fewer but much larger vessels than those found in the tap root. They are fairly evenly distributed. Wood fibres are sparse and immediately contiguous to the vessels. There is an extensive thinwalled unlignified parenchyma. Wood rays, broadening outward, are confluent with the tangentially placed parenchyma of the wood. Starch grains are abundant in the parenchymatous elements. The primary xylem aggregations of 4-5 contiguous elements can be noted clearly. The extensive development of parenchyma in both the tap and lateral roots suggests the storage function of the root.

Gossampinus malabarica Merr.

(=*Bombax malabaricum* DC.)

I. *General Remarks and External Features.*—It is a deciduous tree with a straight erect, buttressed trunk and wide spreading branches. The stem and branches are armed with conical prickles. It is very common and found widely distributed throughout India and Burma. The root system (Pl. M) consists of a greatly thickened fleshy tap root, reddish tan in colour, somewhat cylindrical and tapering upwards and downwards from the fleshy part. A few or many lateral roots arise chiefly from the upper part of the main root.

II. *Internal Structure*.—(Figs. 103-110). A cross section of a thin slender lateral root reveals a wide periderm, deep-seated in origin. In very young roots, the cells directly abutting upon the spices of the phloem wedges are seen to divide thus indicating that the phellogen arises just outside the phloem. In such sections, no phellogen was observed, but in older roots there are found a few layers of rounded or oval cells with intercellular spaces intervening between the phellogen and the tips of the phloem wedges. These obviously constitute the phellogen. The phellem is a broad band of thinwalled rectangular cells with straight outlines. The phloem is made up of triangular wedges converging towards the periderm and separated by centrifugally broadening rays. Each wedge-shaped mass is composed of tangential bands of sieve tissue elements and phloem parenchyma alternating with phloem fibre strands and separated radially by secondary phloem rays. Starch grains, druses and brownish contents are frequently present in the wide phloem rays. The stele is pentarch. The wood is diffuse porous, with large vessels, rather distant, solitary or mostly in radial groups. Tyloses are abundant and often plugged with brown contents (mucilage). Wood parenchyma is abundant. Metatracheal zonate parenchyma forms a reticulum with the wood rays. Wood fibres, angled and irregularly distributed throughout the mass of xylem, alternate concentrically with wood parenchyma. Wood rays, usually uni biseriate are thinwalled. The pith, when present, consists of thinwalled parenchyma. All the parenchymatous elements are filled with starch grains, druses, dark brown contents and mucilage.

The fleshy tap root consists mainly of storage tissue produced by a cambium. This, instead of forming normal vascular elements, gives rise for the most part to unligified parenchyma. A few wood elements slightly lignified, however, are formed at intervals but owing to the extensive development of parenchyma these become isolated as islands aligned radially. There is a central core of lignified woody elements which indicates that the cambium in the young root produces, at first, normal vascular tissue. The tracts of lignified elements may be clearly compared and brought into relief in slices of the root treated with phloroglucin and hydrochloric acid. There is also an extensive development of wood and phloem rays. The phloem forms a broad zone as compared to the corresponding phloem of the less tuberised laterals, the greater mass being composed of phloem parenchyma. Together, the xylem and phloem form a massive storage tissue heavily charged with starch, mucilage and tannin.

Lanea grandis Engl.

(= *Odina Woodier* Roxb.)

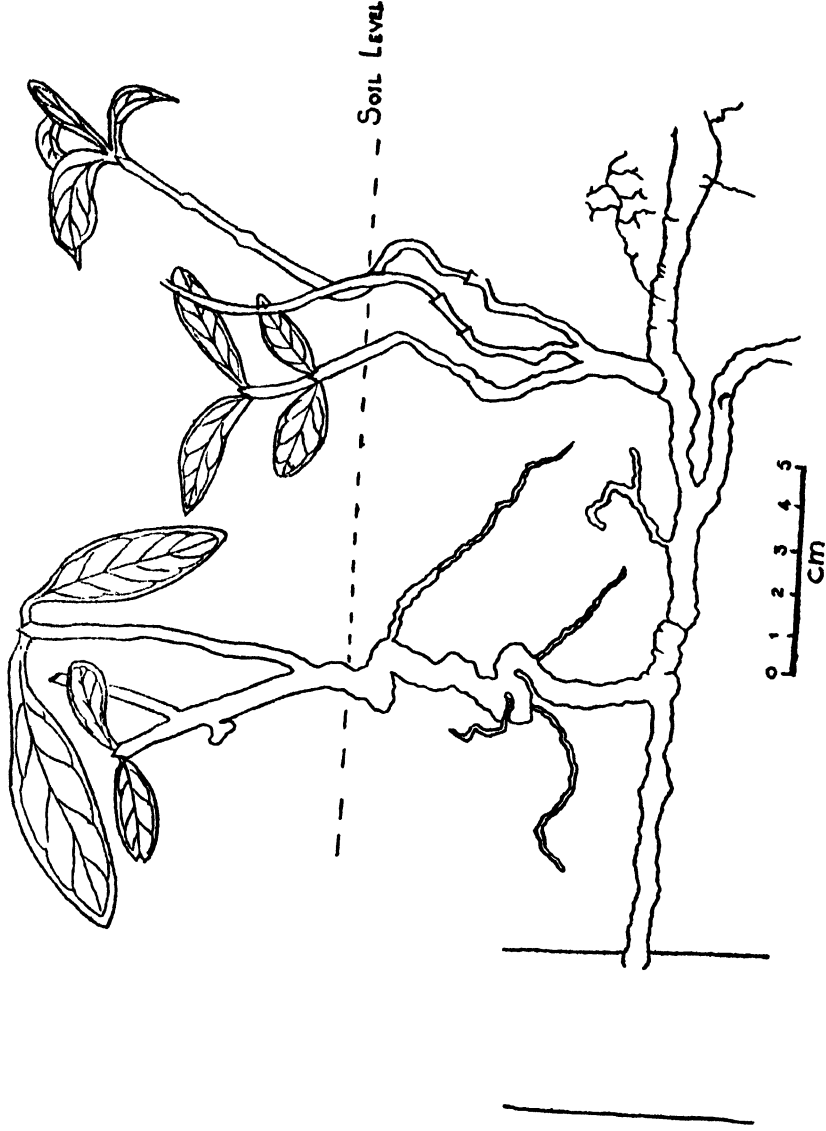
I. *General Remarks and External Features*.—This is a moderate sized deciduous tree with a spreading crown, stout branchlets and compound imparipinnate leaves, crowded about the ends of branches. It is a common tree in mixed deciduous forests throughout the greater part of India and is also found in Ceylon and Burma. The root system (Pl. N.) consists of a thick somewhat fleshy, cylindrical, tapering primary root with long fibrous laterals.

II. *Internal Structure*.—(Photo XIX; Figs. 111-115). A transverse section of a thin, slender lateral root shows a periderm deep-seated in origin which is seen to graduate from an inner transparent zone of thin-walled rectangular phellem cells with extremely sparse yellowish to orange brown contents through cells which become deeper in colour outwards till finally the outermost rows of cells form a complete opaque dark brown band. On the inner side, the periderm again graduates into 4-6 rows of oval cells which also become opaque forming a yellowish brown band round the central cylinder. This is obviously the phellogen and its position with reference to the strands of pericyclic stone cells which are found immediately inside indicate that the phellogen which has given rise to the periderm has its origin just outside the stele. The secondary phloem is characterised by ragged tangential bands of irregularly angled phloem fibres alternating with corresponding sieve tissue elements and phloem parenchyma holding brown contents (tannin). As the ray parenchyma also holds dark contents, the phloem masses appear to be separated into tangentially elongated areas. Gum canals are distributed in the phloem. Associated with the phloem fibres are solitary crystal idioblasts. Rhombohedral crystals, druses and starch grains are distributed in the phloem rays. The wood is diffuse porous. The secondary xylem is characterised by numerous fair sized vessels evenly distributed and generally with contiguous rays on one or both sides. The majority are solitary, 2-contiguous or in radial rows of 3-4. Tyloses occur, well developed in the outer zones but feebly so towards the centre. Orange brown contents and globose echinulate crystal bodies occur in the cells of the tyloses. The greater bulk of the wood is composed of diffuse parenchyma and of fibres aligned in radial rows and tangentially flattened. Wood rays are usually uni-, bi-, rarely triseriate. Orange brown contents are relatively copious. Starch grains are few. Here and there echinoid bodies resembling crystals are to be seen. The stele is 7-arch. The pith consists of thickwalled lignified cells holding starch.

The fleshy tap root is characterised by a massive development of storage tissue which constitutes the bulk of the tuber. As in *Gossampinus malabarica*, there is a central core of lignified tissue which shows that normal vascular elements are at first formed by the cambium. Later on, the cambium produces for the most part unlignified elements. The greater part of this tissue consists of a massive storage parenchyma in which are seen distributed feebly lignified vessels, aligned distantly in radial rows. The phloem also forms a rather broad band composed mainly of storage parenchyma. Starch is the main ergastic product.

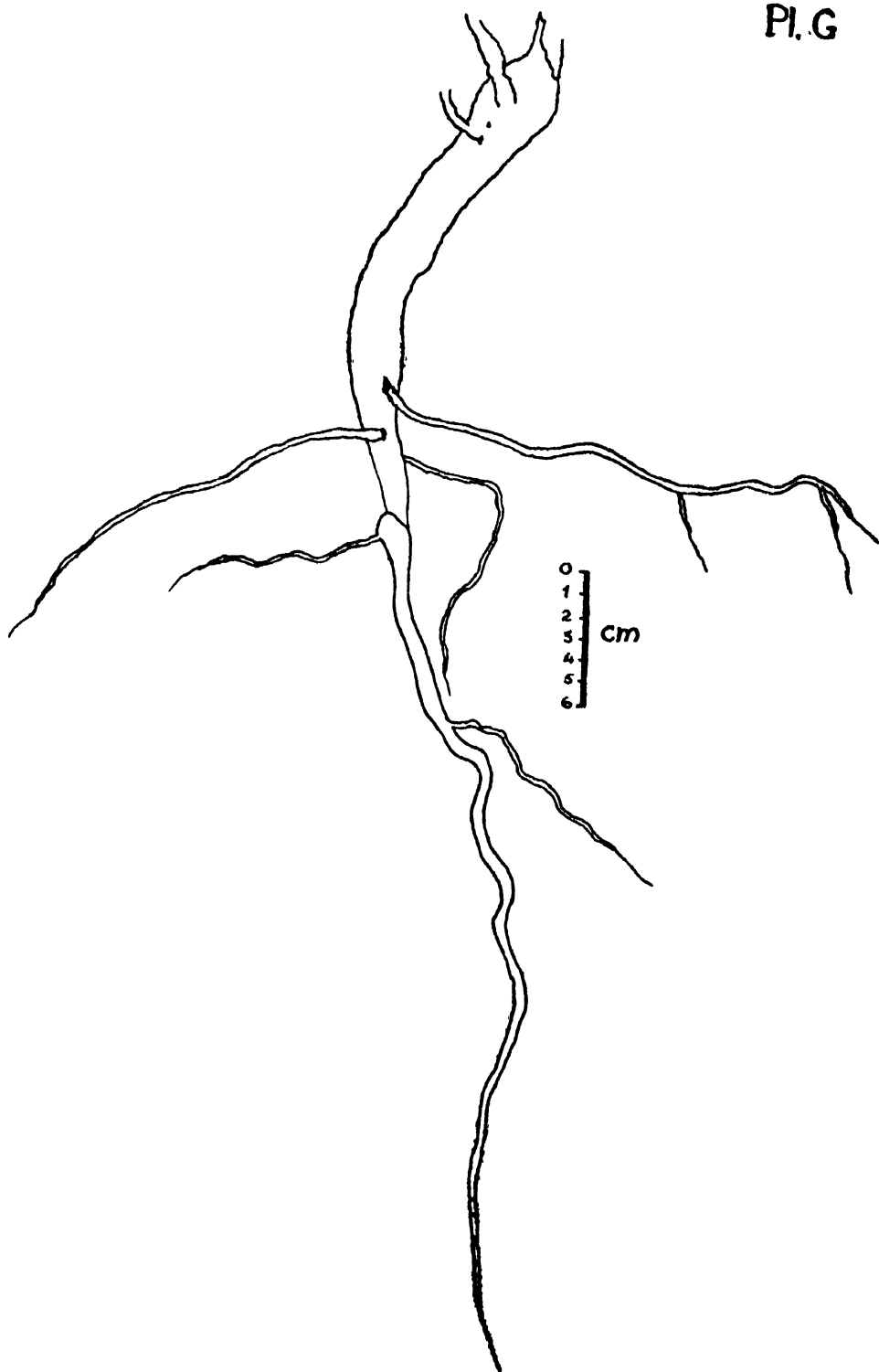
(To be continued)

Pl. F



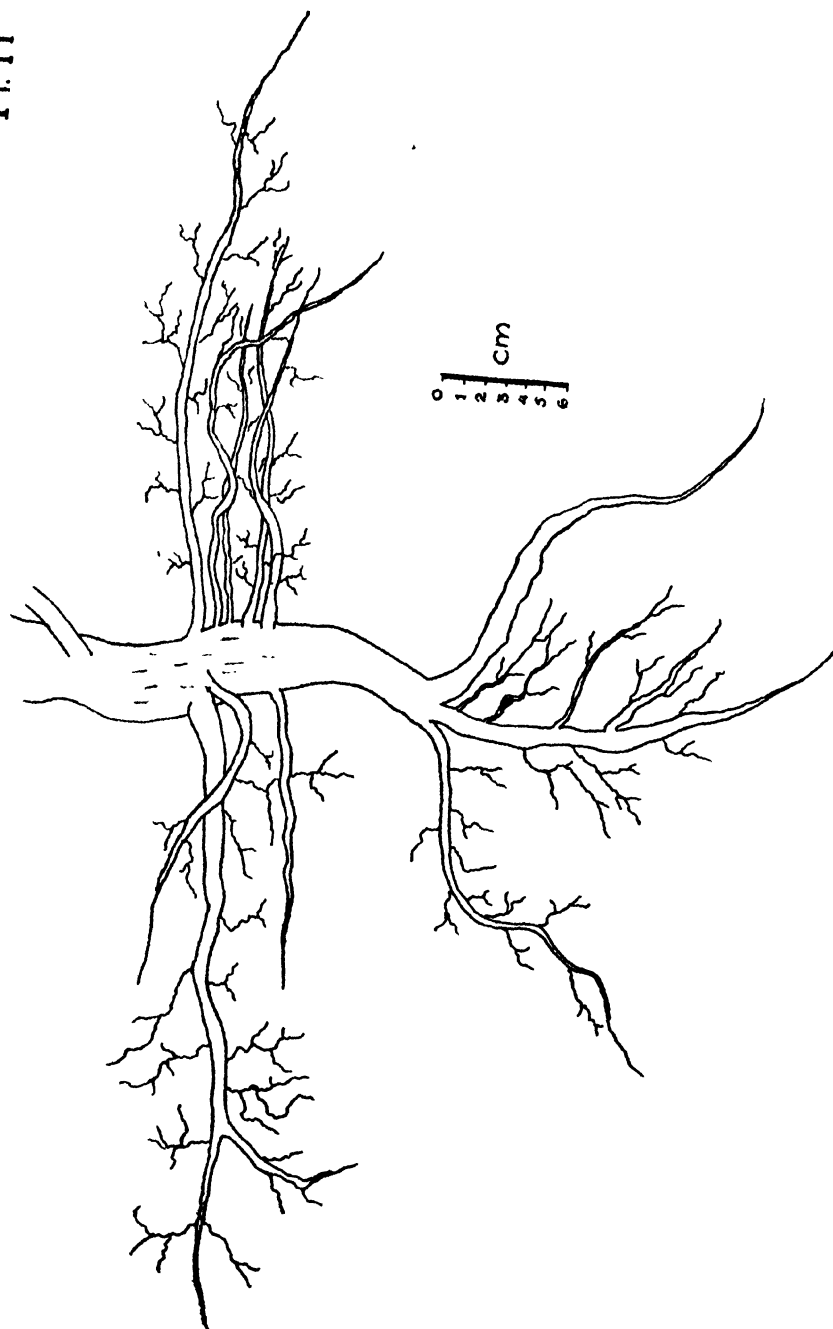
Root habit of *Ixora alba*. Linn.

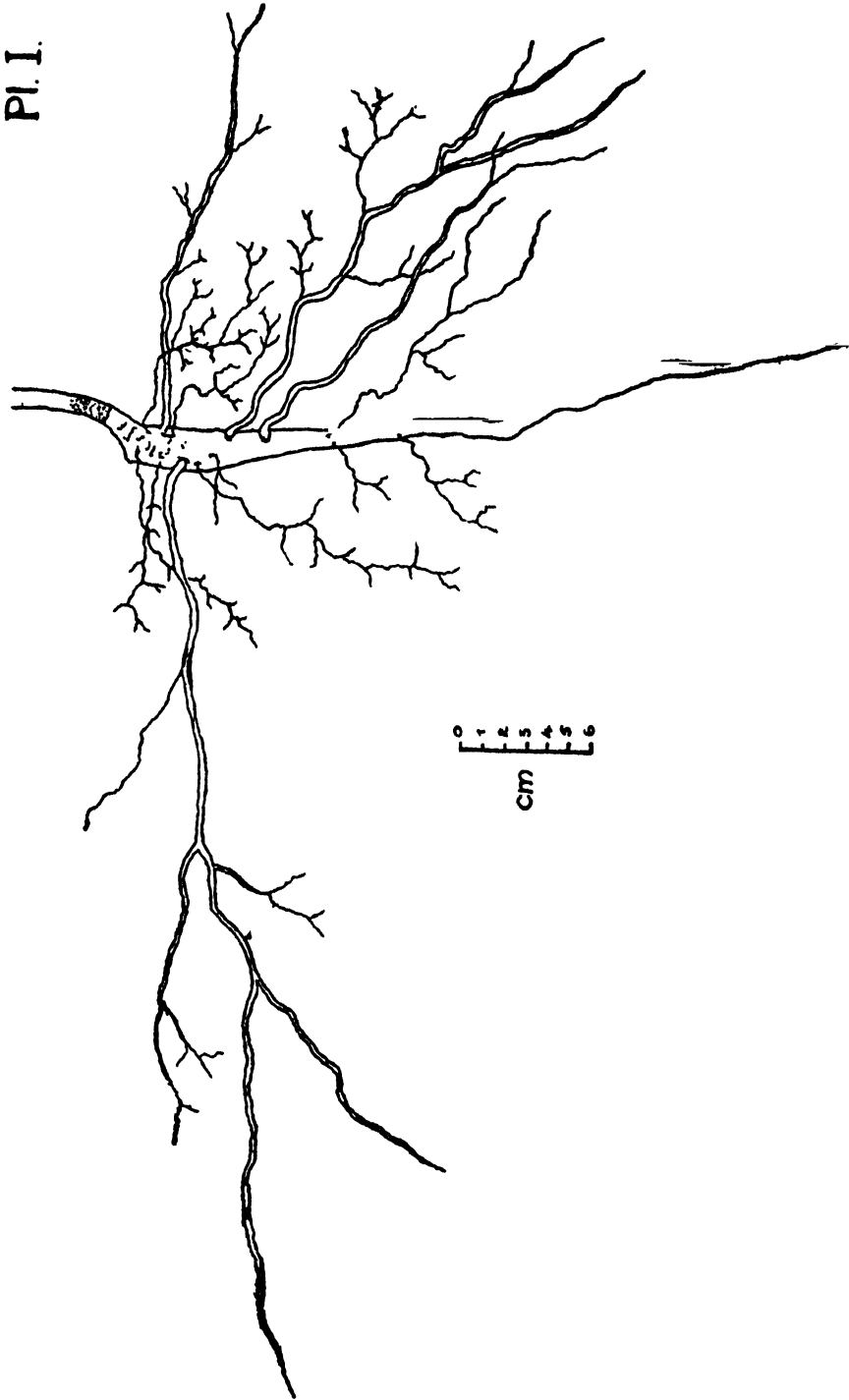
Pl. G



Root habit of *Carissa carandas* Linn.

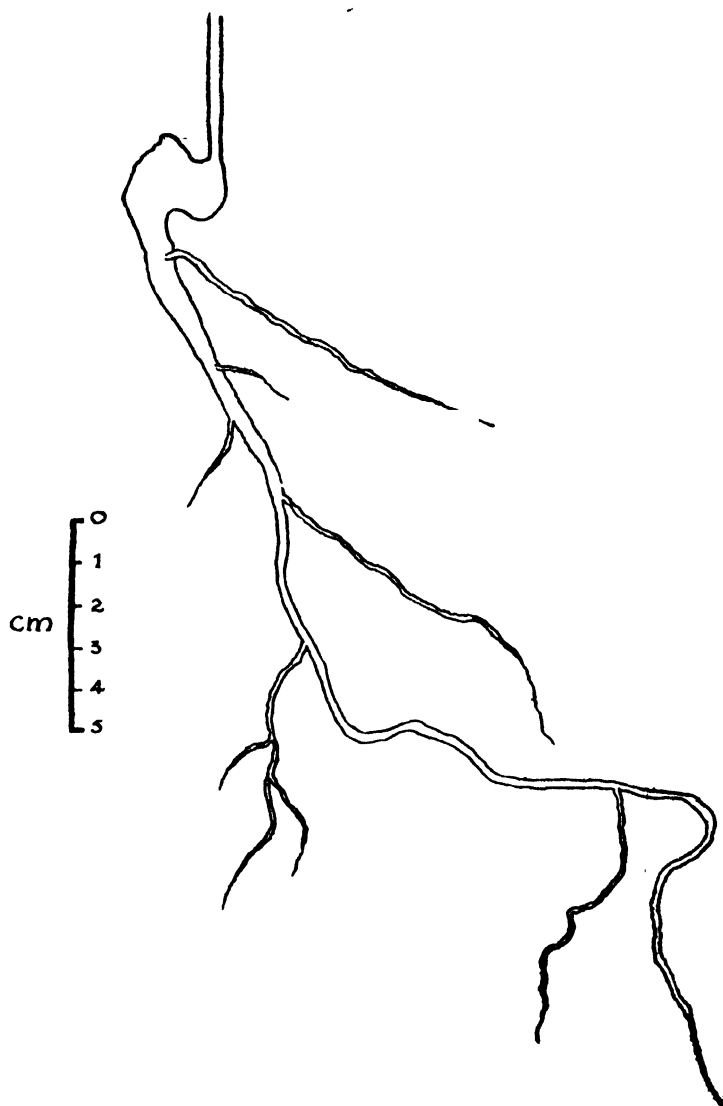
Pl. H

Root habit of *Lantana Camara* Linn.

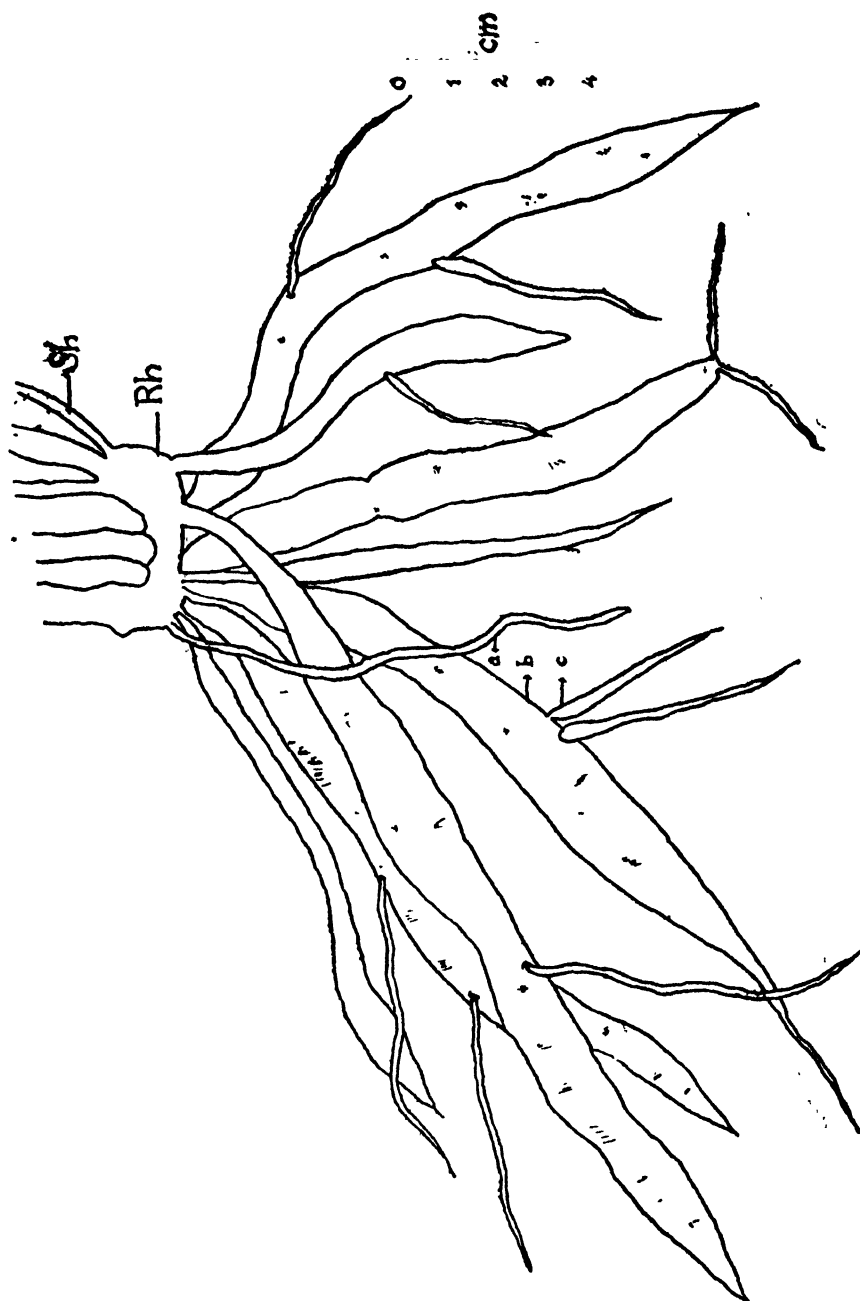


Root habit of *Careya arborea* Roxb.

Pl. J.

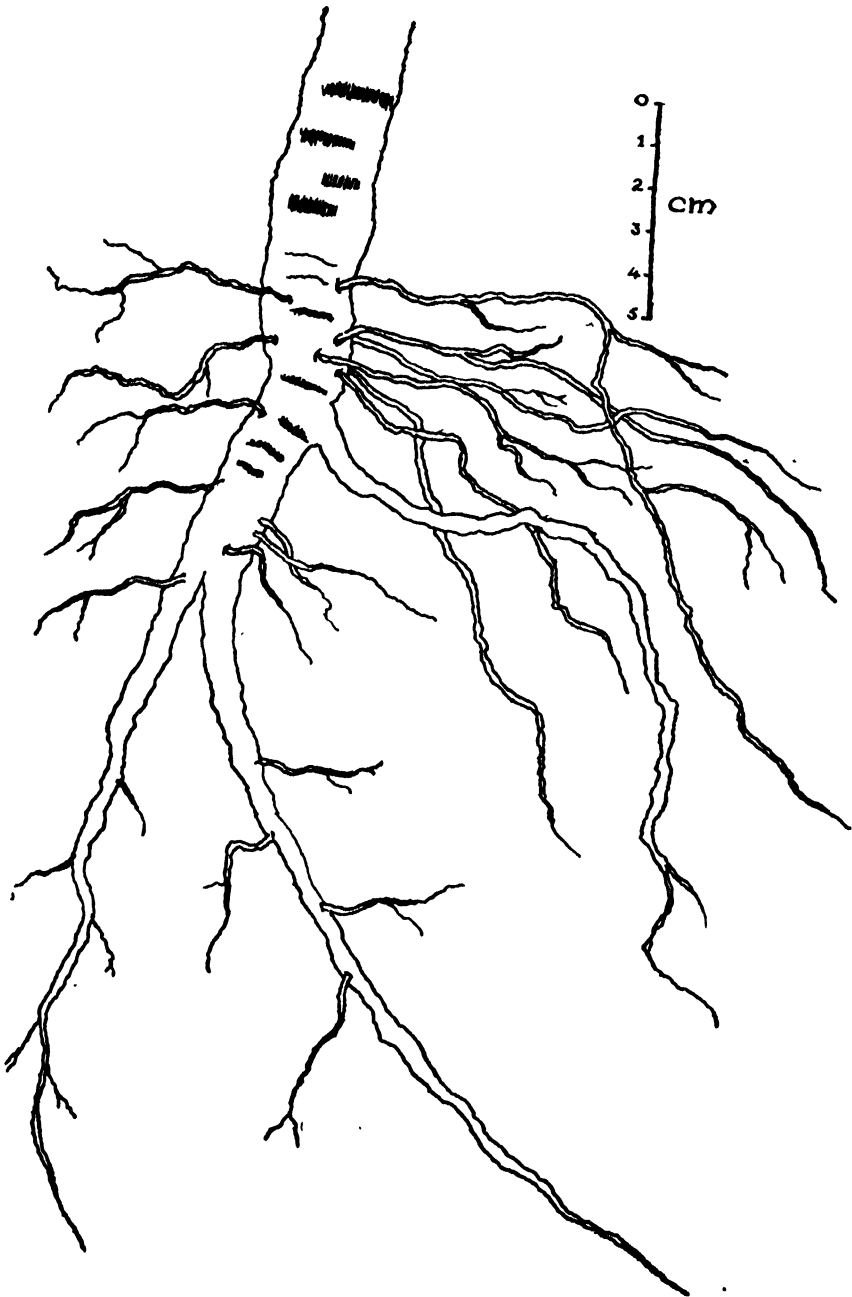
Root habit of *Bridelia retusa* Spreng.

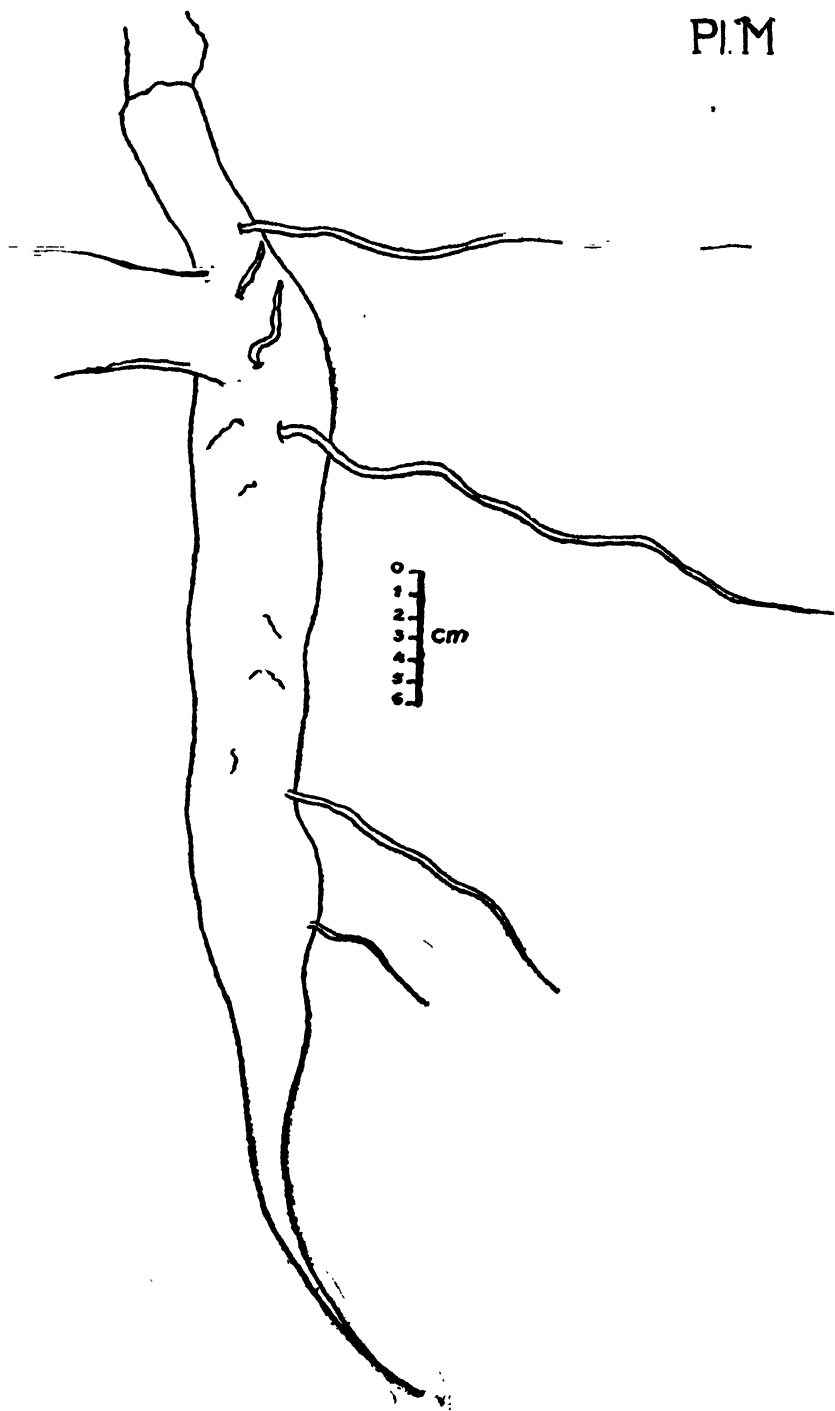
P.K.



Root habit of *Leea sambucina* Willd. Showing *Sh*, Shoot base; *Rh*, shortened subterranean stem; *a*, slender flexible adventitious root; *b*, tuberous root; *c*, branches of the tuberous root.

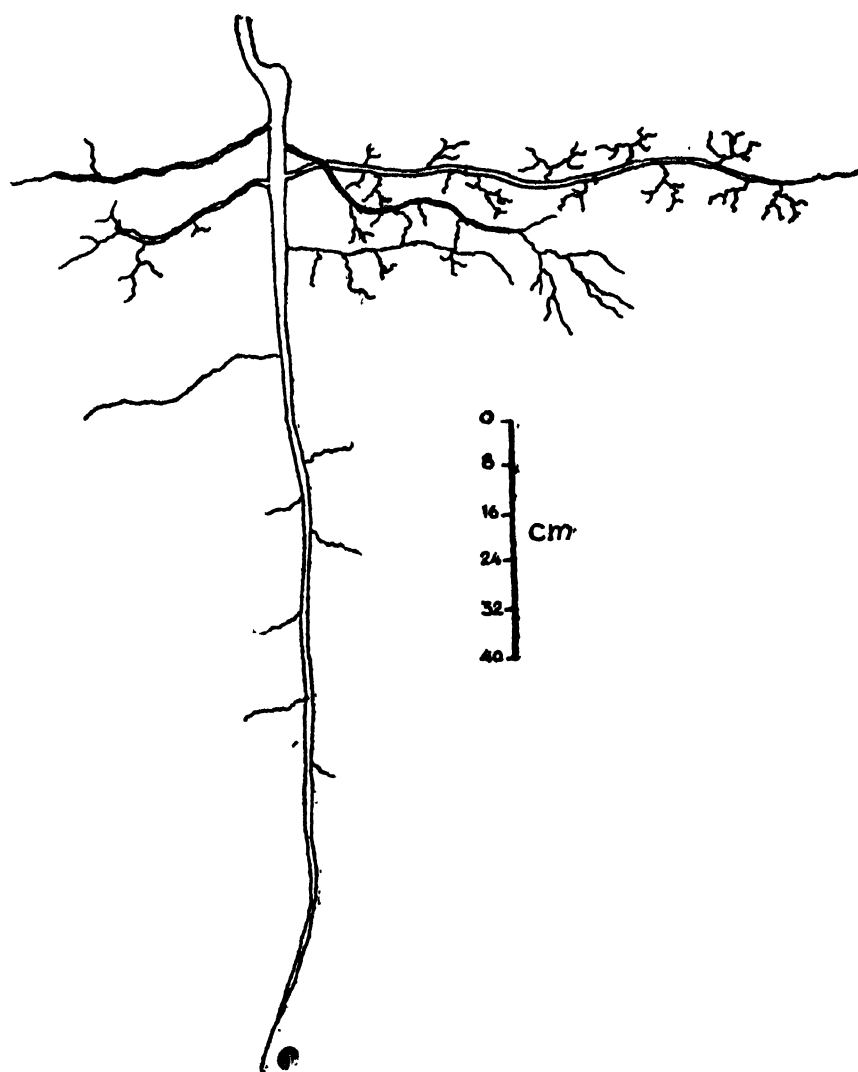
Pl. L

Root habit of *Datura fastuosa* Linn.

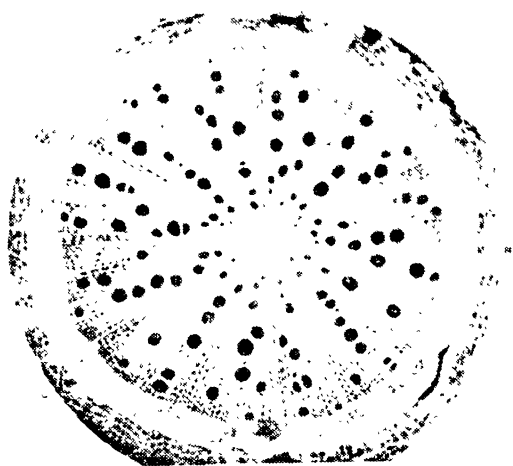


Root habit of a young plant of *Gossampinus malabarica* Merr.

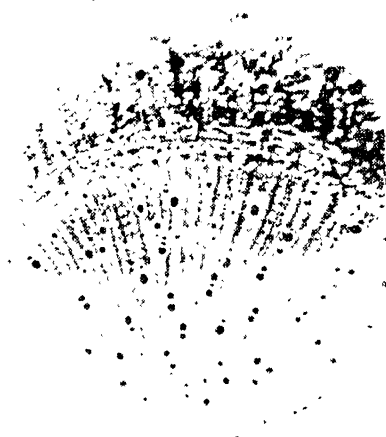
Pl. N.



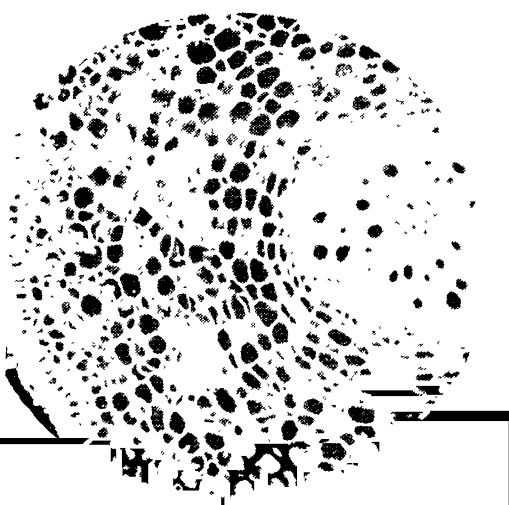
Root habit of a young plant of *Lannea grandis* Engl.



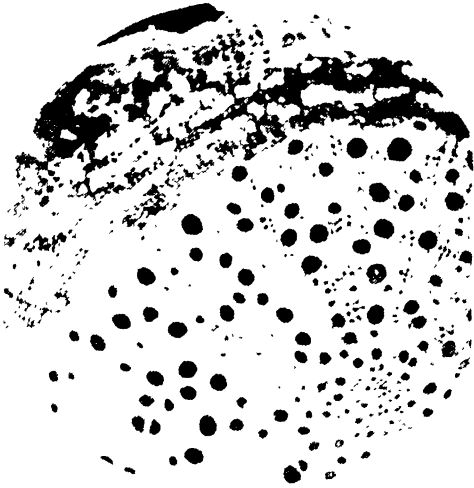
Vitex Negundo Linn.
XI.—T. S. of the root.



Careya arborea Roxb.
XII.—T. S. of the root.



Vangueria spinosa Roxb.
XIII.—T. S. of a young root.



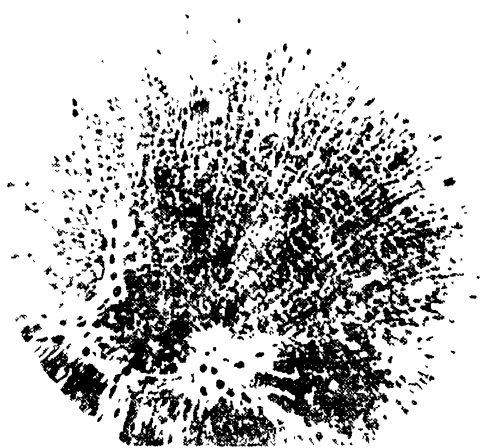
Bridelia retusa Spreng.
XIV. T. S. of an old root.



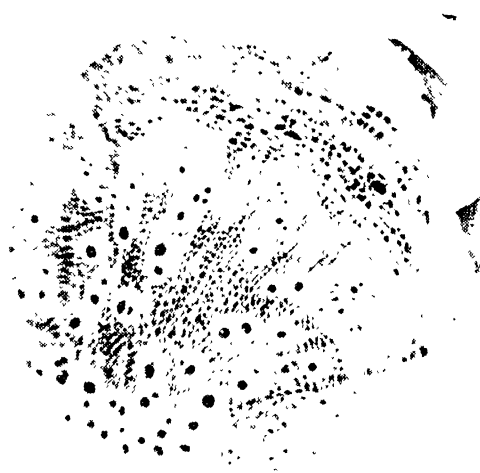
Leca sambucina Willd.
XV.-- T. S. of the root.



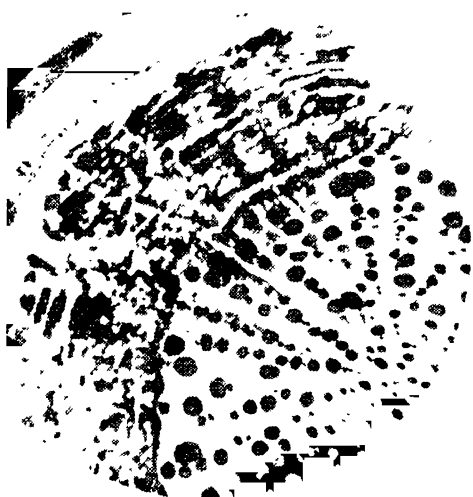
XVI. T. S. of a slender flexible root showing slight initiation of secondary growth. Outer suberised layers, cortex, 3 groups of xylem and phloem and massive storage pith can be seen.



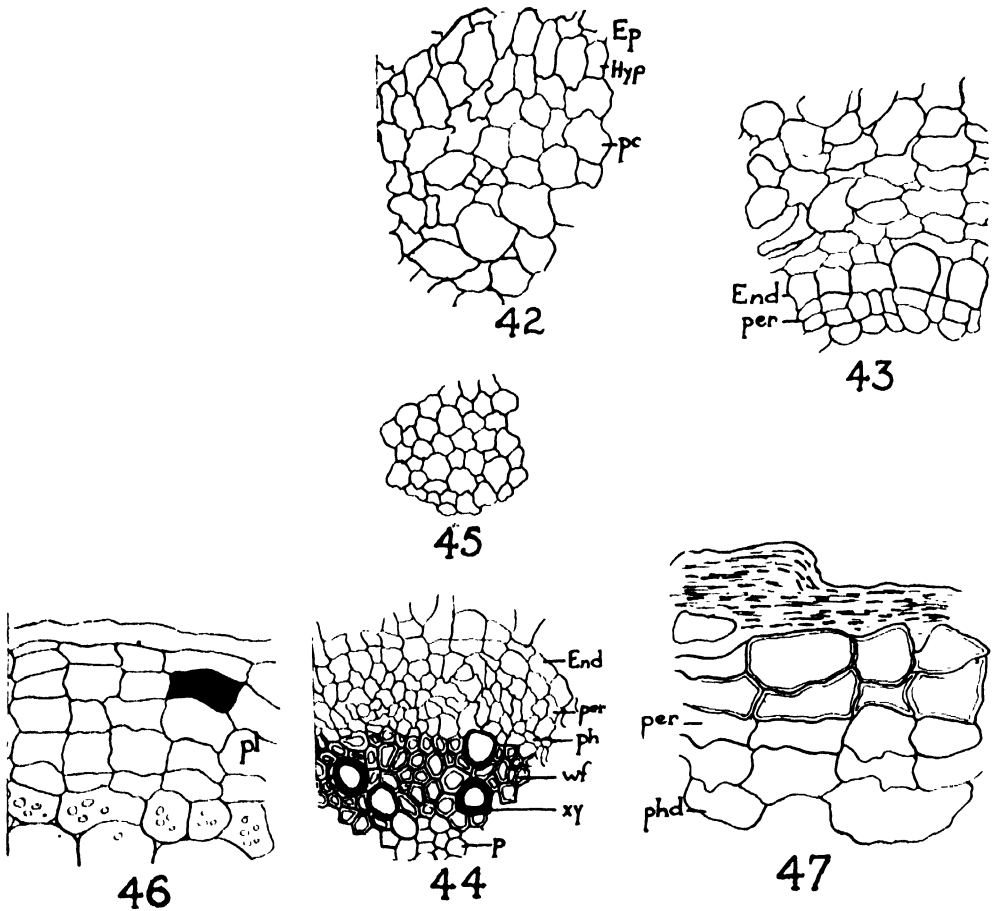
XVII. - T. S. of the tuberous root (central portion) showing 3 primary xylem groups in the centre separated from the metaxylem by unlignified storage parenchyma.



Datura fastuosa Linn.
XVIII. T. S. of the root.



Lannea grandis Engl.
XIX. T. S. of the root.



***Ixora alba* Linn.**

Fig. 42.—Portion of the T. S. of the young root : *Ep*, superficial layer ; *Hyp*, hypodermis ; *Pc*, parenchymatous cortex (x 450).

Fig. 43.—Portion of the T. S. of a young root showing inner cortex : *End*, endodermis ; *per*, pericycle (x 450).

Fig. 44.—T. S. of a young root showing a portion of the central cylinder ; *End*, endodermis ; *per*, pericycle ; *ph*, phloem ; *xy*, xylem ; *wf*, wood fibres ; *p*, pith (x 450).

Fig. 45. T. S. of a young root showing the thinwalled pith (x 450).

Fig. 46. T. S. of a slightly older root showing : *pl*, thinwalled phellem (x 450).

Fig. 47.—T. S. of a still older root showing phellem cells considerable thickwalled ; *per*, pericyclic phellogem ; *phd*, phelloderm (x 450).

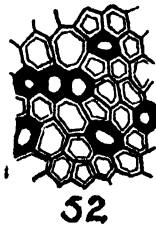
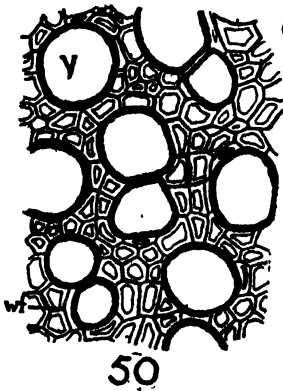
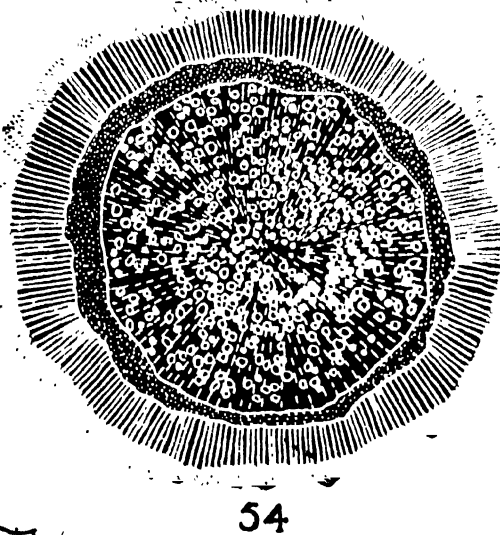
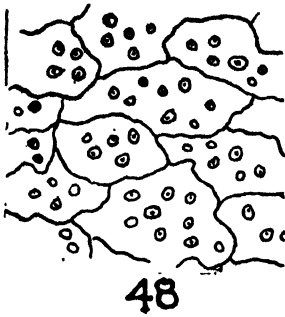


Fig. 48.—T. S. of a still older root sucker showing phelloderm cells packed with starch grains ($\times 450$).

Fig. 49.—T. S. of an old root showing : *ph*, phloem tissue with crystals *Xy*, xylem ($\times 450$).

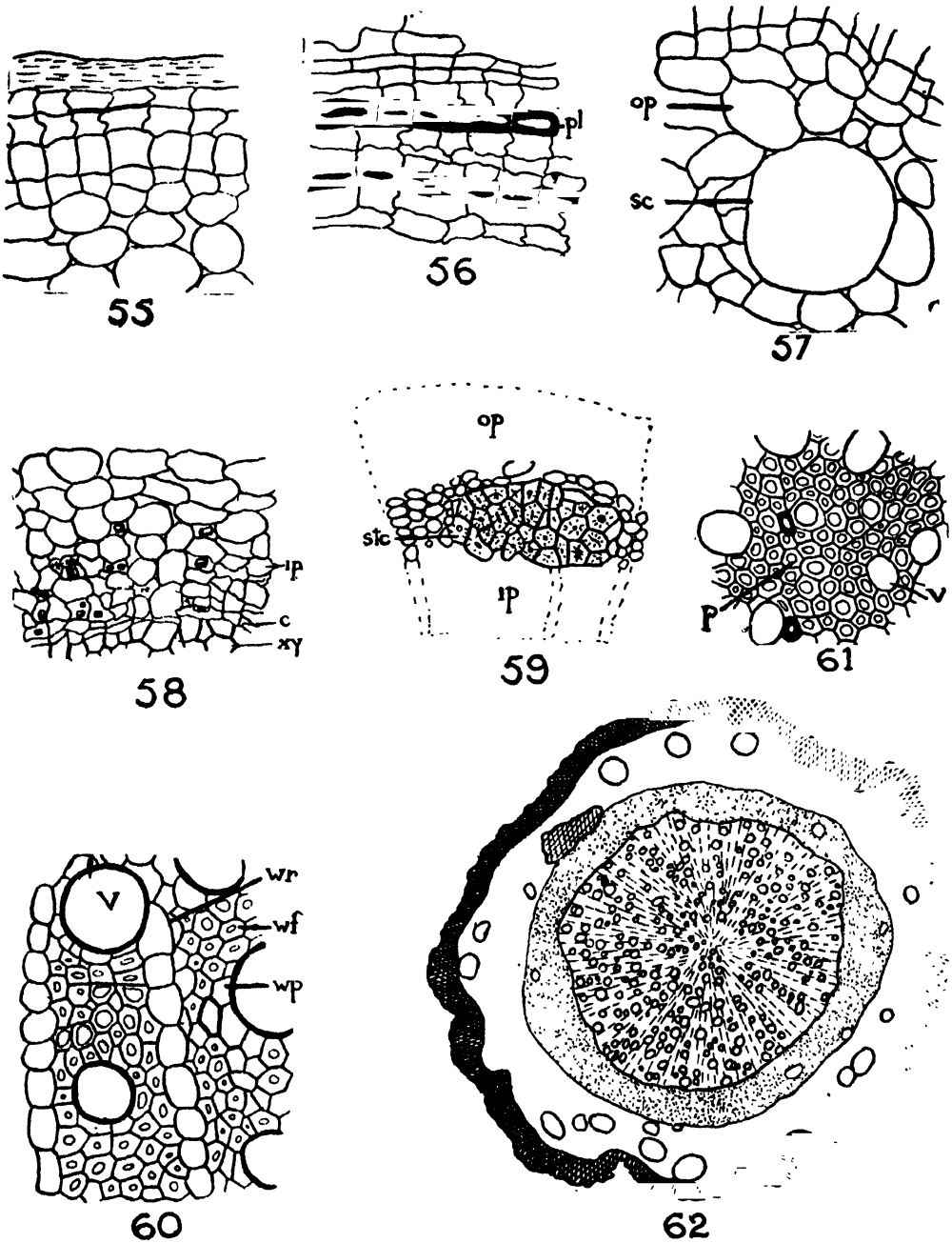
Fig. 50.—T. S. of an old root showing close up of wood : *V*, vessel ; *wf*, wood fibres ($\times 450$).

Fig. 51.—T. S. of an older root showing wood fibres blocked with black contents ($\times 450$).

Fig. 52.—T. S. of an old root showing a heterogenous pith ($\times 450$).

Fig. 53.—T. S. (diagrammatic) of a young root showing central cylinder surrounded by phloem (dotted) and phellem (cross hatched) ($\times 50$).

Fig. 54.—T. S. (diagrammatic) of an old root sucker showing tissues as in Fig. 53. Phelloderm hatched ($\times 50$).



***Carisa Carandas* Linn.**

Fig. 55.—Portion of the T. S. of a young root showing phellem (x 450).

Fig. 56.—Portion of the T. S. of an old root showing : *pl*, phellem concentrically stratified due to differential thickenings (x 450).

Fig. 57.—Portion of the T. S. of a young root showing : *op*, outer phloem ; *sc*, secretory canals (x 100).

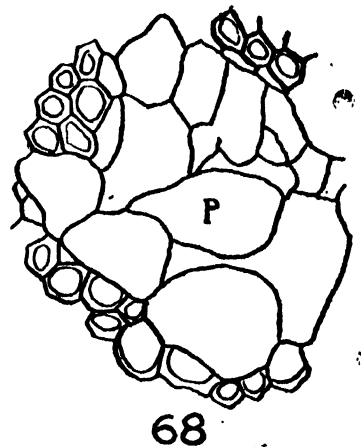
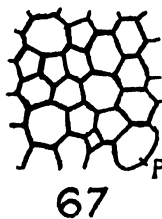
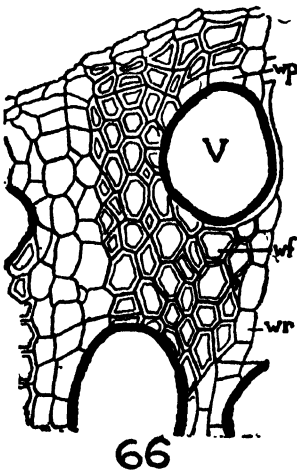
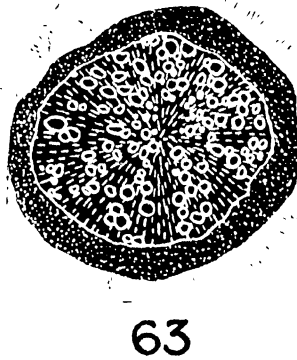
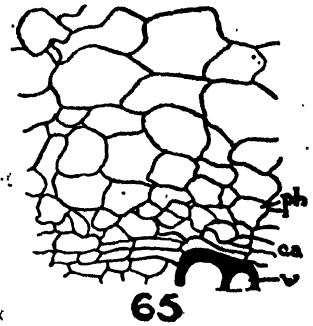
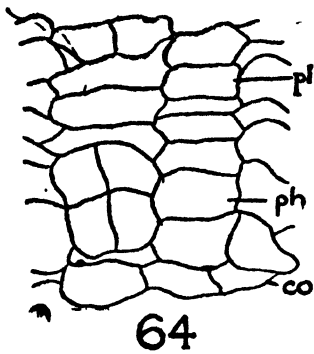
Fig. 58.—Portion of the T. S. of a young root showing : *ip*, inner phloem with cells containing crystals ; *c*, cambium ; *xy*, xylem (x 450).

Fig. 59.—Portion of the T. S. of an old root showing : *stc*, stone cells groups in the inner phloem ; *op*, phloem ; *ip*, inner phloem (x 100).

Fig. 60.—Portion of the T. S. showing close up of wood : *V*, vessel ; *wf*, wood fibres ; *wr*, wood rays ; *wp*, wood parenchyma (x 450).

Fig. 61.—Portion of the T. S. of a young root showing lignified pith (x 450).

Fig. 62.—T. S. (diagrammatic) of the root showing central woody cylinder surrounded by phloem (dotted). Secretory canals blank circles among dots. Stone cells hatched. Phellem cross hatched (x 25).



***Lantana Camara* Linn.**

Fig. 63.—T. S. (diagrammatic) of the root showing central woody cylinder surrounded by phloem (dotted). Phellem cross hatched (x 25).

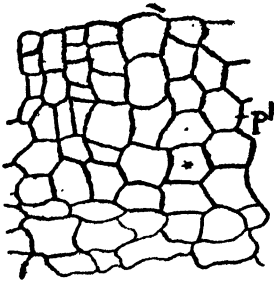
Fig. 64.—Portion of the T. S. of the root showing: *pl*, phellem; *ph*, phellogen cells in active division; *co*, parenchyma on the inner side of the phellogen (x 450).

Fig. 65.—Portion of the T. S. of the root showing: *ph*, phloem; *ca*, cambium; *w*, wood (x 450).

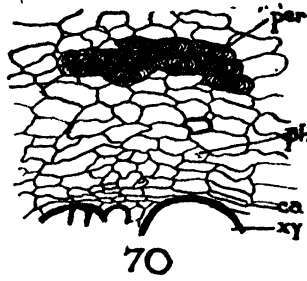
Fig. 66.—T. S. of the root showing close up of wood. *V*, vessel; *wf*, wood fibres; *wr*, wood rays; *wp*, wood parenchyma (x 450).

Fig. 67.—Central portion of the T. S. of the root showing: *p*, pith cells thickwalled and lignified (x 450).

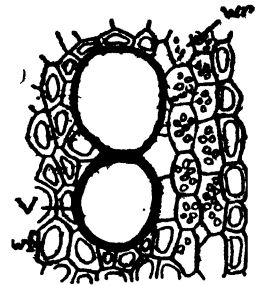
Fig. 68.—Central portion of the T. S. of the root showing: *p*, balloon shaped thin-walled cells in sclerosed pith (x 450).



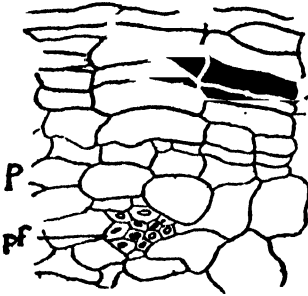
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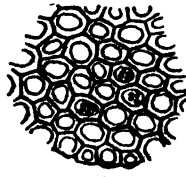
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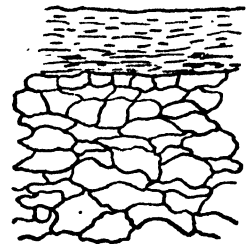
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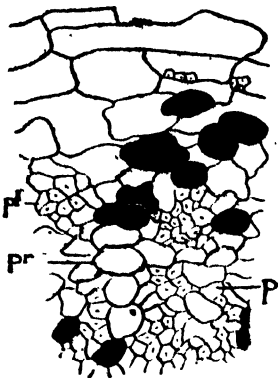
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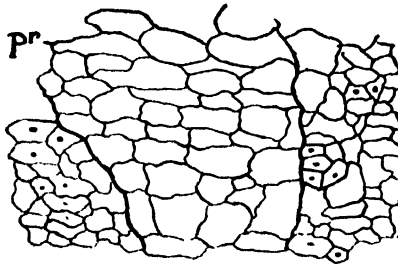
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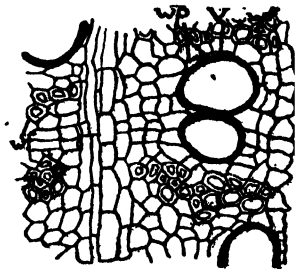
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Vitex Negundo Linn.

Fig. 69.—Portion of the T. S. of the root showing : *pl*, irregular shaped phellem (x 450).

Fig. 70.—Portion of the T. S. of the root showing : *per*, pericyclic stone cells and parenchyma ; *ph*, phloem ; *ca*, cambium ; *xy*, xylem (x 450).

Fig. 71.—T. S. of the root showing close up of wood : *V*, vessel ; *wf*, wood fibres ; *wr*, wood rays (x 450).

Fig. 72.—Central portion of the T. S. of the root showing sclerosed pith cells (x 450).

Careya arborea Roxb.

Fig. 73.—T. S. of the slender root showing phellem abutting against phloem (x 360).

Fig. 74.—T. S. of the stout root showing phellem abutting against phloem : *p*, soft phloem (x 360).

Fig. 75.—T. S. of the slender root showing the phloem tissue : *pf*, phloem fibres ; *pr*, phloem rays ; *p*, soft phloem. Cells containing tannin black (x 360).

Fig. 76.—T. S. of the stouter root showing sieve tissue elements and phloem fibres on either side of broad phloem rays, (*pr*) (x 360).

Fig. 77.—T. S. of the slender root showing close up of wood : *V*, vessels ; *wf*, wood fibres ; *wp*, wood parenchyma (x 360).

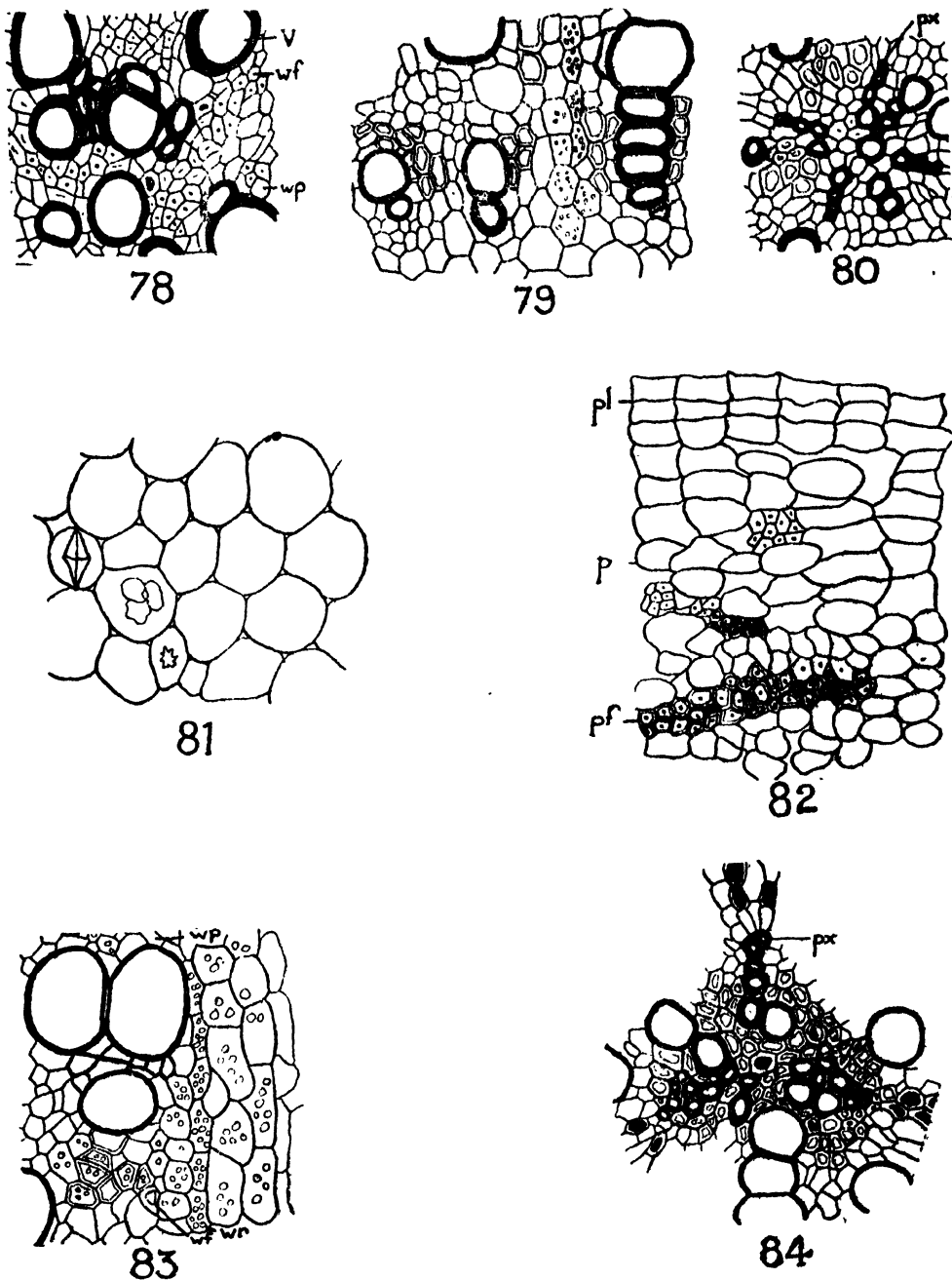


Fig. 78.—T. S. of the stout root showing close up of wood : *V*, vessels ; less strong lignified ; *wf*, wood fibres ; *wp*, wood parenchyma ; *wr*, wood rays (x 225).

Fig. 79.—Same as Fig. 18. Close up of wood abutting against pith (x 450).

Fig. 80.—T. S. of the central portion showing disposition of the primary xylem elements, (*px*) (x 450).

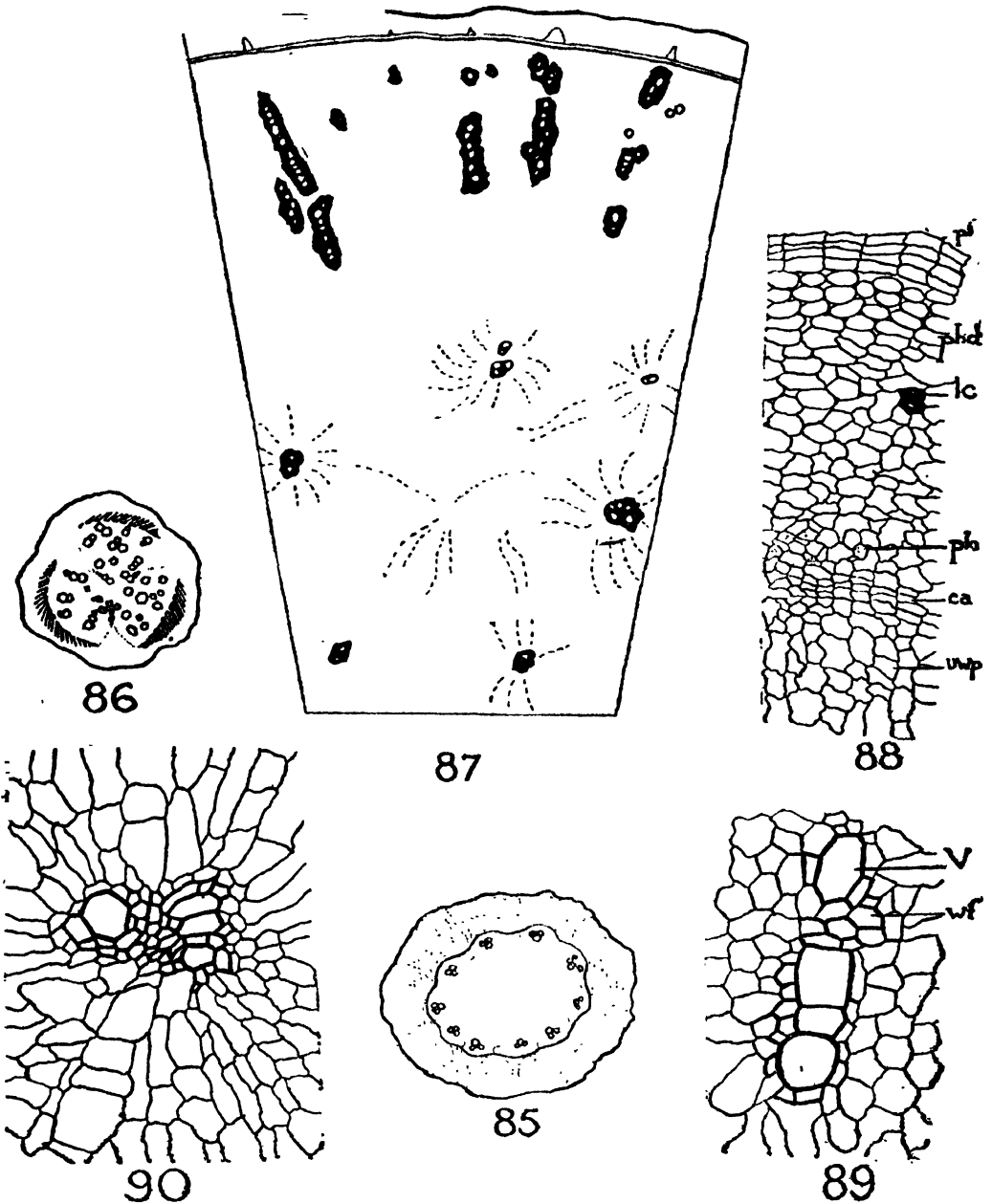
Fig. 81.—T. S. of the central portion of the stouter root showing a storage pith (x 450).

Bridella retusa Spreng.

Fig. 82.—T. S. of the root showing : phellem, (*pl*) abutting against the phloem, (*p*) ; *pf*, phloem fibres (x 360).

Fig. 83.—T. S. of the root showing a close up of wood : *V*, vessels ; *wf*, wood fibres ; *wp*, wood parenchyma ; *wr*, wood rays (x 450).

Fig. 84.—T. S. of the central portion of the root showing disposition of the primary xylem groups, (*px*), (x 450).



***Leea sambucina* Willd.**

Fig. 85.—T. S. (diagrammatic) of the slender flexible root showing 10-arch arrangement. Ground tissue (cortex and pith) dotted ($\times 16$).

Fig. 86.—T. S. (diagrammatic) of the tuberous root at the extreme tip showing triarch stele with compact secondary wood. Phloem hatched; groups of round lignified cells outside the phloem shown black; phelloderm dotted; peripheral black outline represents the phellem ($\times 16$).

Fig. 87.—T. S. (diagrammatic) of the fleshy tuber showing islands of lignified wood embedded in unlignified parenchyma white. Vessels 1, 2, 3 in the centre; wavy lines indicate the trend of the central mass of parenchymatous cells; cambium shown as double lines; phloem wedges dotted; peripheral black outline represents the phellem ($\times 16$).

Fig. 88.—T. S. of the fleshy tuber (peripheral portion) showing: *pl*, phellem; *phd*, phelloderm; *lc*, lignified cells; *ph*, phloem; *pr*, phloem rays; *ca*, cambium; *unwp*, unlignified xylem tissue ($\times 150$).

Fig. 89.—T. S. of the fleshy part of the tuber showing lignified xylem consisting of vessels, *V*, *wf*, wood fibres surrounded by unlignified xylem parenchyma ($\times 150$).

Fig. 90.—T. S. of the fleshy tuber (central portion) showing a single isolated primary xylem group surrounded by parenchyma ($\times 150$).

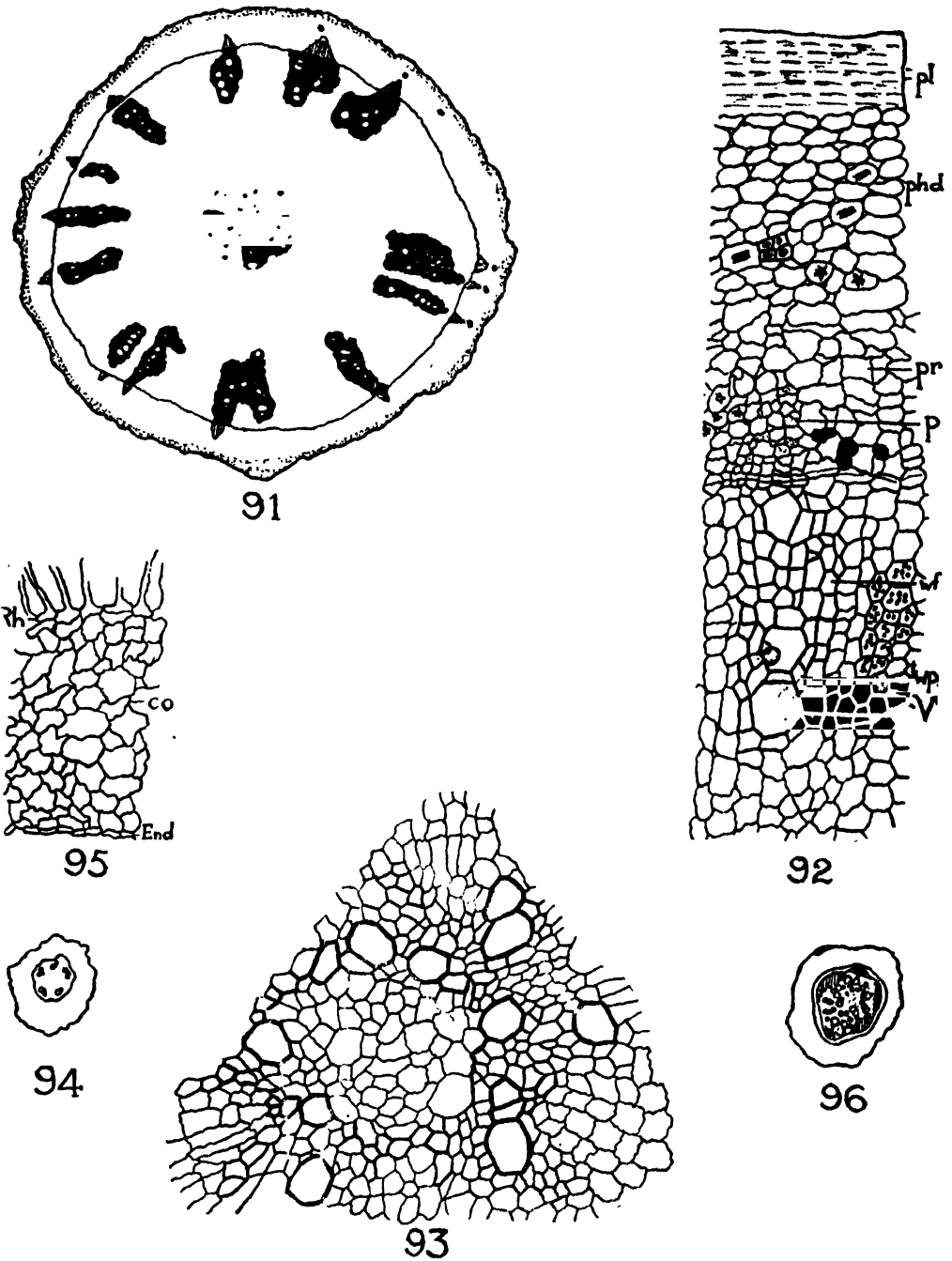


Fig. 91.—T. S. (diagrammatic) of the proximal part of the root showing greater amount of lignified tissue as compared with the tuberous root. Shading and explanation in text of Fig. 87. (x 16).

Fig. 92.—T. S. of the proximal part of the tuber (peripheral portion) showing: *V*, vessels; *wf*, wood fibres; *lup*, lignified parenchyma. Rest as in Fig. 87. (x 150).

Fig. 93.—T. S. of the proximal part of the tuber (central portion) showing unligified pith in the centre bounded by 3 primary xylem strands (x 150).

Fig. 94.—T. S. (diagrammatic) of the lateral root showing the pentarch arrangement (x 16).

Fig. 95.—T. S. of the lateral root (peripheral portion): *Rh*, root hairs; *co*, cortex; *End*, endodermis (x 150).

Fig. 96.—T. S. (diagrammatic) of the lateral root showing secondary growth, Phloem hatched. Endodermis a black line (x 16).

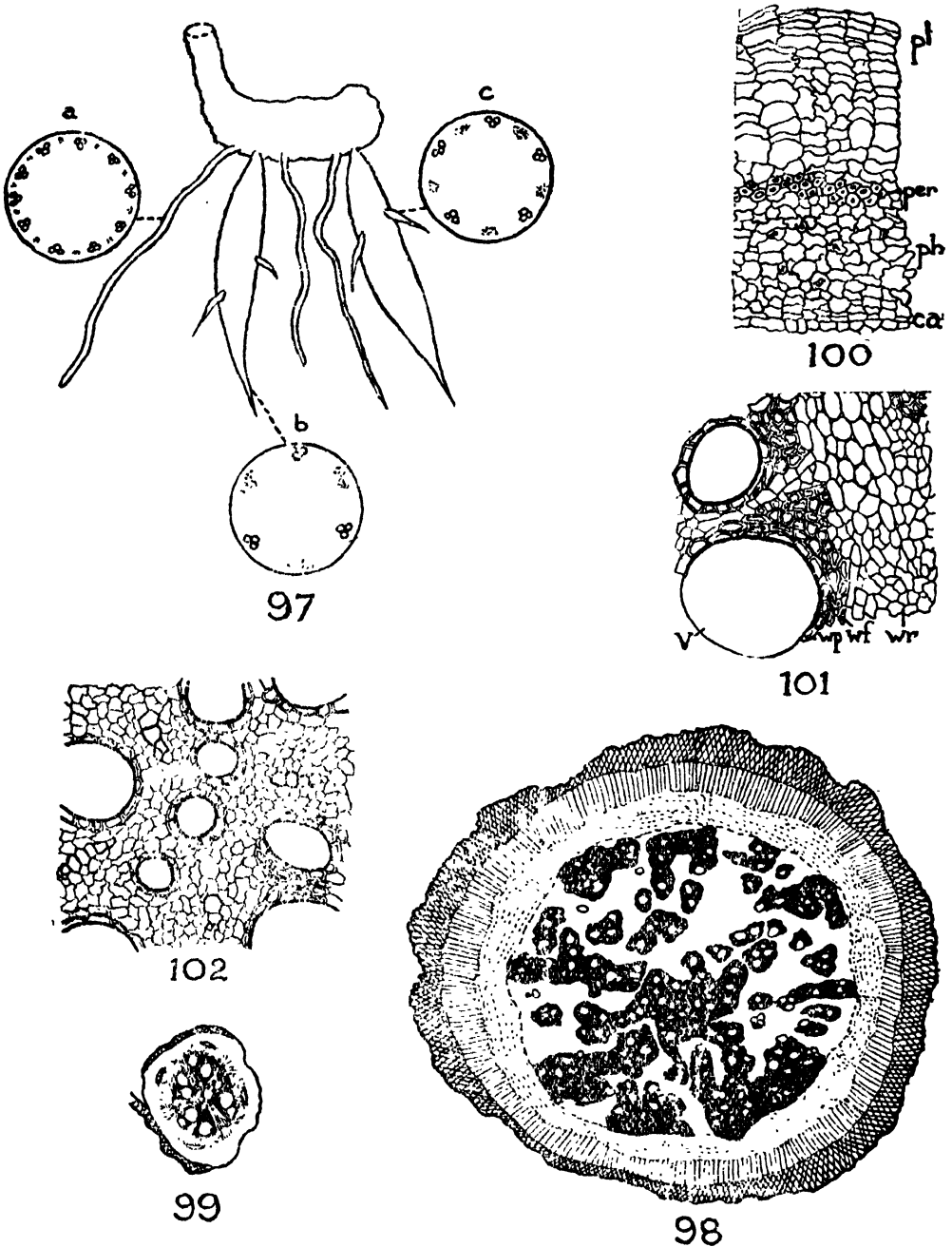


Fig. 97.—Diagram showing heterarchic nature of root system. Explanation as in text.

Datura fastuosa Linn.

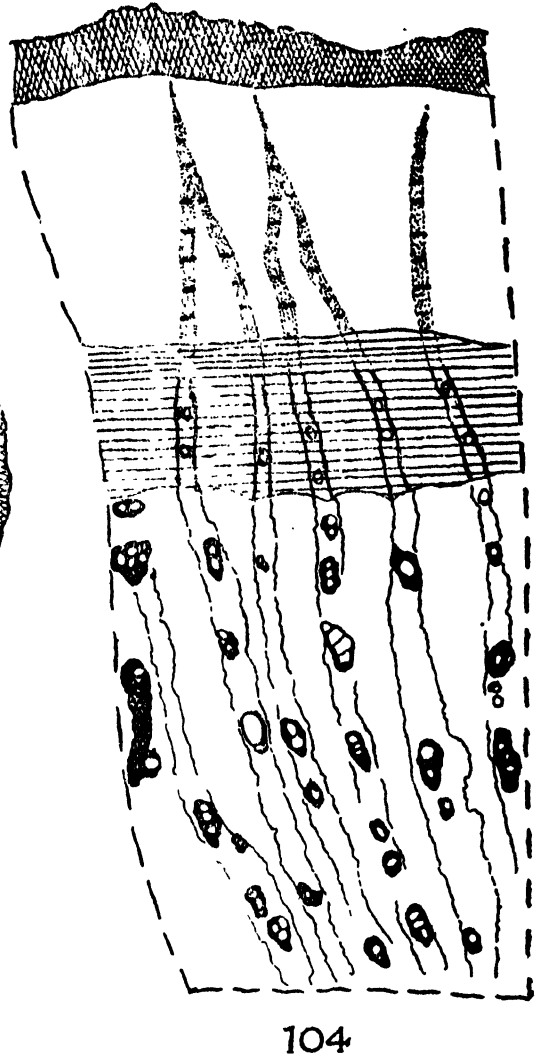
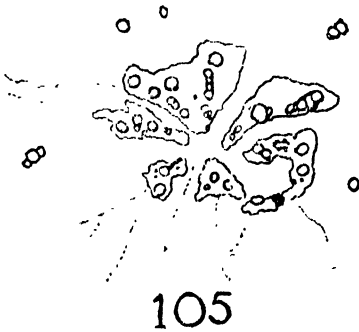
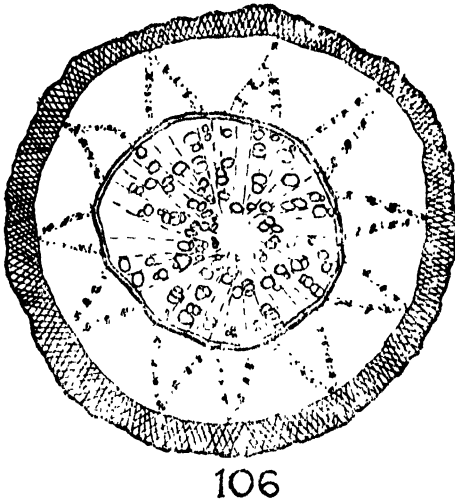
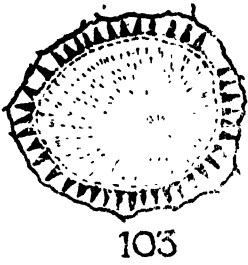
Fig. 98.—T. S. (diagrammatic) of the tap root showing islands of lignified tissue consisting of vessels surrounded by other lignified elements black; unlignified xylem white; phloem dotted; phelloderm hatched; phellem cross hatched ($\times 16$).

Fig. 99.—T. S. (diagrammatic) of the lateral root showing lignified elements black; vessels blank circles in the black; phloem dotted; rays as radial lines; phelloderm unshaded; phellem cross hatched ($\times 16$).

Fig. 100.—T. S. of the slender lateral showing: *pl*, phellem; *per*, pericyclic fibres; *ph*, phloem; *ca*, cambium ($\times 225$).

Fig. 101.—T. S. of the slender lateral showing a portion of the metaxylem; *V*, vessels; *wf*, wood fibres; *wp*, wood parenchyma; *wr*, wood rays ($\times 225$).

Fig. 102.—T. S. of the slender lateral (central portion) showing primary xylem elements ($\times 225$).



Gossampinus malabarica Merr.

Fig. 103.—T. S. (diagrammatic) of the fleshy tap root. Lignified portions of the wood shown by radial lines. Outer wood disposed in rings (annual rings) cambium shown as concentric lines. Phloem black. Parenchyma white. Phellem shown as black lines peeling off at the periphery. Natural size.

Fig. 104.—T. S. (diagrammatic) of the fleshy tap root showing phellem, cross hatched; phloem dotted; phloem fibres, black; cambium hatched; phloem ray parenchyma, white; vessels surrounded by lignified tissue shown black; unligified xylem shown cloudy ($\times 16$).

Fig. 105.—T. S. (diagrammatic) of the fleshy tap root (central portion) showing primary xylem elements ($\times 16$).

Fig. 106.—T. S. (diagrammatic) of slender lateral root. Phellem cross hatched; phloem ray parenchyma white; phloem dotted; phloem fibres black; cambium shown as double line surrounding the wood ($\times 16$).

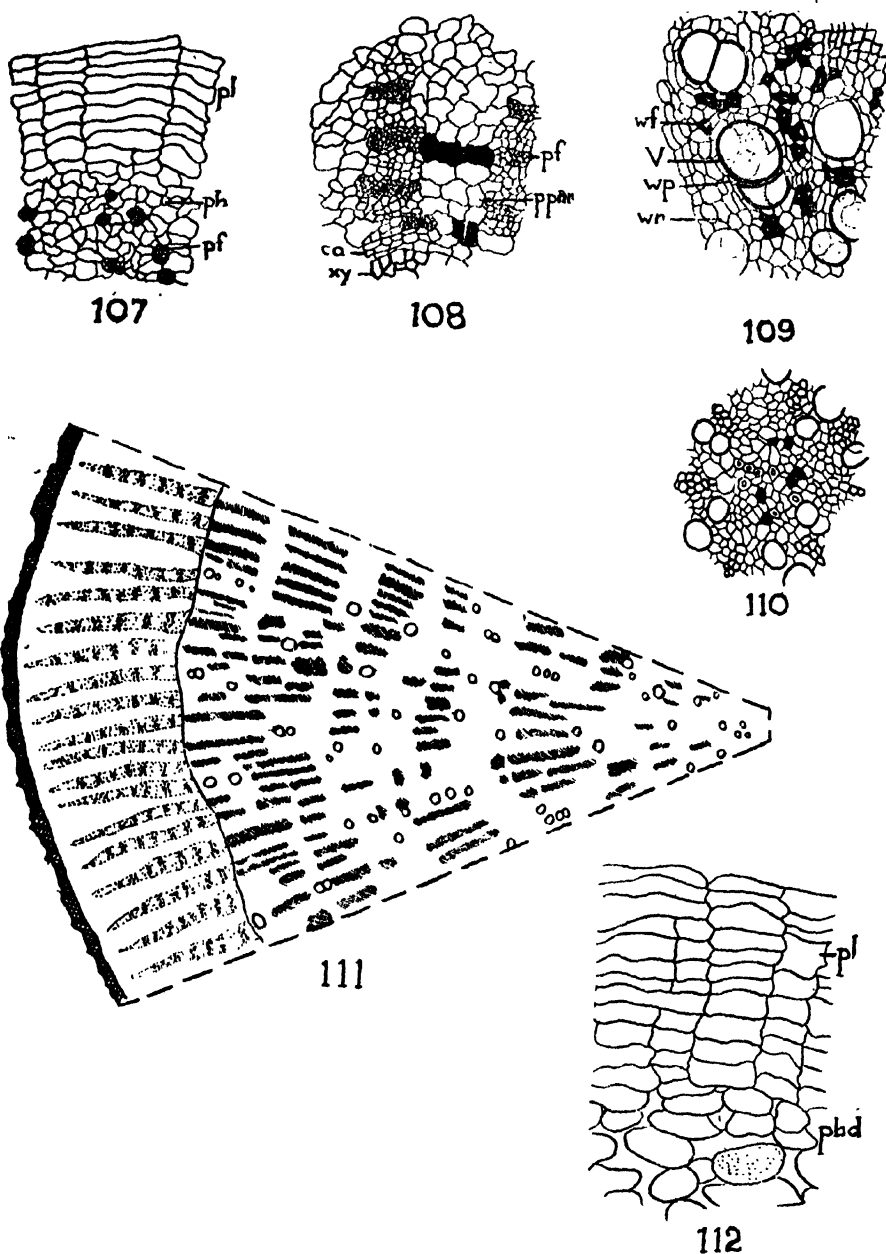


Fig. 107.—T. S. of the slender root showing: *pl*, phellem abutting against *ph*, phloem; *pf*, phloem fibres (x 50).

Fig. 108.—T. S. of the slender root showing a portion of the inner phloem with *pf*, phloem fibres alternating with sieve tissue elements and separated by *ppar*, phloem ray parenchyma. Cells with brown contents black; *ca*, cambium; *xy*, xylem (x 50).

Fig. 109.—R. S. of the slender root showing close up of wood: *V*, vessels with tyloses. *wp*, paratracheal parenchyma; *wf*, wood fibres; *wr*, wood rays (x 50).

Fig. 110.—T. S. of the slender root (central portion) showing the heptarch arrangement of the primary xylem elements (x 50).

Lannea grandis Engl.

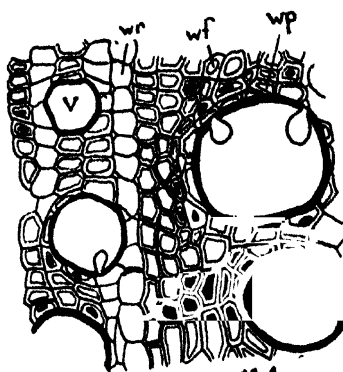
Fig. 111.—T. S. (diagrammatic) of the fleshy tap root showing phloem cross hatched; phloem dotted; phloem fibres black; cambium lined; ray parenchyma unshaded; vessels outlined black; wood fibres hatched (x 240).

Fig. 112.—Portion of the T. S. of the root showing: *pl*, phellem; *phd*, phellogen (x 450).



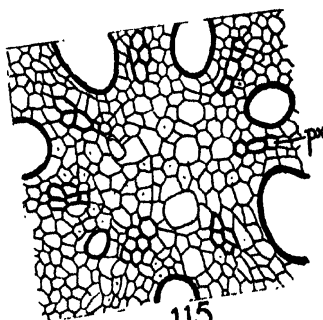
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Fig. 113.—Portion of the T. S. of the root showing inner phloem tissue; *p*, phloem fibres; *p*, Sieve tissue elements; cells with tannin shown black ($\times 450$).



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Fig. 114.—T. S. of the root showing close-up of wood: *V*, vessel with tyloses; *wp*, wood parenchyma; *wf*, wood fibres; *wr*, wood rays ($\times 450$).



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Fig. 115.—T. S. of the root (central portion) showing the disposition of the primary xylem (*px*) elements round the central pith ($\times 360$).

THE MARINE PELECYPODA OF BOMBAY

By

T. V. SUBRAHMANYAM, K. R. KARANDIKAR AND N. N. MURTI

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Introduction

IN the vast field of 'shell collection' many a field-naturalist has 'put in his sickle but the harvest is so abundant that even the most negligent search of a straggling gleaner may be rewarded with a sheaf.' Shell life in sea is as rich as insect life on land both in quantity and variety. Except in the frigid zone where it is extremely cold, the sea coasts of the world have their own representatives of molluscan life. The opulence and splendour of Mollusca of the tropical Indo-Pacific Region are too well known to need any special mention. "A tropical beach especially where there is a good tide fall and considerable variety of station, abounds in Mollusca to an extent which must literally be seen to be believed." Since the days of the Expedition of H.M.S. "Challenger," much marine Biological work has been done especially in Conchology—the study of Molluscan Fauna. Many collections have been made since 1887 from the coasts of India and Burma, and lists of such collections are available in the principal museums and libraries. There is still much more to know about the shells of the Indian sea coasts not only with regard to the number of species but also their ecology and distribution.

So far as the Bombay shells are concerned, the only comprehensive catalogue available is the list of the marine Mollusca of Bombay, published by Messrs. Melvill and Abercrombie in the Memoirs and Proceedings of the Manchester Literary and Philosophical Society—Session 1892—1893. Although more than fifty years have now elapsed since its publication, no addition or supplement to this list appears to have been made so far. In the Proceedings of the Zoological Society of London (1906) however, Messrs. Melvill and Standen, in dealing with the Mollusca of the Persian Gulf, Gulf of Oman and Arabian Sea, have included the Bombay shells also, previously enlisted in Melvill and Abercrombie's list, with a few additions and slight changes in the nomenclature.

The following paper contains an account of the bivalves collected by us from the Bombay sea-shore. It marks an advance over Melvill & Abercrombie's list in that a few more species, not recorded previously, have been included here and an attempt is made to give the description and ecology of many of the shells recorded. Melvill's list includes the Mollusca occurring both in and around Bombay and also some from the Konkan coast up to Ratnagiri; whereas the present list is based chiefly on the collections made from the beach between Dadar and Bandra of the Bombay Island. Out of the 95 species of Lamellibranchs catalogued by Melvill and Abercrombie occurring in the whole of Bombay we have been able to secure from Mahim beach alone 90 species of Pelecypoda, besides a good many others which were not recorded before. A more careful search, under the guidance of more experienced Ecologists and employment of dredging and trawling methods, should undoubtedly reveal many more species of Mollusca in this area and their distribution in height.

The one drawback of Bombay is that many parts of the local sea-shore are rocky and at the same time muddy owing to the constant shifting of black slime and dirt through the creeks around. The coastal waters are never clear but always brackish, and the condition is rendered worse by the discharge of the city sewage all around. This is perhaps the chief reason why the number of species of the marine Mollusca of Bombay is less than that in other parts of the Indian sea-coast like Madras and Rameshwaram.

The dirty nature of the waters also conceals many species from the eyes of the collector, while the trap rocks render dredging operation difficult and even impossible. With all her drawbacks, however, Bombay has several beautiful species of Mollusca to her credit and shell collection here is by no means a less interesting or fascinating hobby than in Madras or any other sea-port of India.

For the purpose of our study under the above caption we selected the beach between Dadar and Bandra, because apart from the factor of personal convenience, experience has revealed that this portion of Bombay is an ideal locality for shell collection in so far as it presents a range of different sites favouring the existence of different kinds of Molluscan life. Thus towards its north the Bandra creek opens into the Mahim Bay, and in its expansive estuary fluviatile species of bivalves thrive. Just south to this area are chains of rocks covered with mud and with characteristic oyster-belts. Here is an ideal place for the study of the shore-rock fauna. Most of the members of Ostreidae, Mytilidae, Anomiidae, Pectinidae and Arcidae can be collected from here in the living condition. To the south of this rocky region is the sandy beach with mud flats and lagoons. In this area the littoral zone, exposed during low tides, is very extensive, and here is a hot-bed for bivalves of different kinds. During the monsoon many species, which are rare in other seasons of the year, are collected.

"The classification of Pelecypoda has long presented great difficulties, for the different structures such as shell, muscles, siphons, etc., that have successively been employed as bases of classification, have not given satisfactory results." In the phylogenetic classification of Lamellibranchs into Orders, it is the structure and disposition of the respiratory

gills that are at present depended upon, and Ray Lankester was the first to suggest the taxonomical value of gills. The arrangement of Orders followed in colleges and Universities is therefore that given in Ray Lankester's *Treatise on Zoology*, Part V, Mollusca (author Pelseneer, 1906). In this paper, however, we have adopted the arrangement given in Thiele's '*Handbuch der Systematischen Weichtierkunde*,' 1931, as this is now widely accepted by all the principal Museums and Malacological Societies.

As the object of this paper is not so much to enlighten the advanced systematist as to guide the field worker and thereby encourage collection work, we have given only a limited number of synonyms. Besides the current names, we have also given the names mentioned in the lists of Melvill and Abercrombie, and Melvill and Standen wherever the nomenclature differs. In several cases we have also referred to Dr. Baini Prashad's Report on Pelecypoda of the Siboga Expedition (1932) wherever the relevant species are dealt with by him. Reference is also made to Dr. Gravelly's Paper on 'Shells and other animal remains found on the Madras Beach' published in the Bulletin of the Madras Government Museum (N.H. Vol. V, 1941).

To enable the readers to sort out their collections into families we have given separately a key and also a list of the Bombay shells including the small number of additional species recorded in this paper.

Although in this paper we have dealt with the species previously recorded and a few others reported by us, we strongly feel that the list is still incomplete, because there are a number of other forms in our collection which have not yet been identified. After Alexander Abercrombie, except for the late Mr. E. H. Aitken, few seem to have really made any earnest attempt to collect shells from these parts. Until an expedition is organised and the collections so made are carefully identified with the help of the up-to-date literature on the subject, the Molluscan Fauna of Bombay can be said to be only incompletely studied. Of the 31 Families of Pelecypoda occurring here, especially Arcidae, Ostreidae, Veneridae (Genus *Sunetta*), Mactridae, Garidae, Tellinidae and Solenidae require to be worked out more exhaustively. We believe that several species so far not recorded, do occur here. Altogether there seems to be much scope for the shell collector to explore this shore further.

Key to Identify the Families of the Bombay Pelecypoda

I. *Shells with well-defined radial ribs or ridges :*

A. *Shells with ears at the umbo.*

1. Ears prominent, unequal or sub-equal; shell surface strongly ribbed or with spines; portion of shell below ears round or sub-oval; colour patches variable....

PECTINIDAE.

2. Ears not prominent; portion below ears semi-circular; no colour patches....

LIMIDAE.

B. *Shells without ears at the umbo.*

1. Shells with hinge straight, long and provided with lamelli-form teeth; shape quadrangular oval, generally longer than broad but variable; ribs single or double....ARCIDAE.
2. Hinge pliodont but strongly curved; shell sub-circular....
GLYCYMERIDAE.
3. Shells solid with strong radiating costae; umbo twisted triangular oval; lateral teeth rudimentary; cardinal teeth two, one small and the other long and oblique....
CARDITIDAE.
4. Shells less solid than in (3), more round and inflated closer ribs; two small but prominent cardinal teeth and one well developed lateral on either side; teeth alike in both the valves....
CARDIIDAE.

II. *Shells plain or marked by concentric growth lines or striations only. Radial ridges if present generally thin.*A. *Shells with no definite or regular shape.*

1. Shells thick and irregular without definite hinge teeth; fixed by the left or larger valve.... OSTREIDAE.
2. Shells equivalve with terminal umbo; hinge with two cardinals and a long posterior lateral; shape variable due to environmental causes.... TRAPEZIIDAE.
3. Shells irregular with subequal valves fixed by one valve; free valve lamellate or spiny; spiral umbo....CHAMIDAE.

B. *Shells with regular shape.*a) *Hinge with no well-defined teeth.*

1. Shells with suppressed umbo not projecting beyond the hinge margin; thin and disc-shaped, translucent....
ANOMIIDAE.
2. Shells not flat, thicker, often elongated with a narrow anterior and a broad posterior; teeth weak; umbo terminal or sub-terminal.... MYTILIDAE.
3. Shells large and thin with narrow anterior and terminal umbo; no teeth.... PINNIDAE.
4. Shells elongated and gaping, thin, with striations or ridges; dorsal margin in part reflected over the umbo; no hinge teeth but a styloid apophysis present in the umbonal cavity.... PHOLADIDAE.
5. Shells long and narrow, gaping at both sides; umbo terminal and not thick; ligament external.... SOLENIDAE.

6. Shells oval, thin and fragile, gaping behind ; hinge with spoon-shaped teeth MYIDAE.
7. Shells completely closing, somewhat thick often with concentric sculpture ALOIDIDAE.
8. Umbo simple; shell small but strong, usually snouted behind; right valve flat, left one convex PANDORIDAE.
- 9 & 10. Umbo divided apparently, shell fragile, somewhat grooved LATERNULIDAE & THRACIDAE.

b) *Hinge with well-defined teeth.*

1. Shells thick, equivalve; shape variable; surface polished, plain or with concentric striations; lunule well-marked ; cardinal teeth well-developed ; three in number and sub-equal laterals variable ; pallial sinus present . . . VENERIDAE.
2. Shells as in (1) with concentric costae . . . PETRICOLIDAE.
3. Shells equivalve, sub-triangular ; ligament external ; two well-developed cardinals, sometimes three ; laterals variable ; pallial sinus deep DONACIDAE.
4. Shells fairly thick, sub-triangular nearly equilateral ; surface polished ; cardinal teeth bifurcated ; laterals pronounced ; ligament partly internal . . . MACTRIDAE.
5. Shells not very thick, rounded or oval, equivalve ; one or two cardinals and one lateral ; ligament in an internal cavity SEMELIDAE.
6. Shells equivalve, sub-triangular oval generally longer than wide, flat or compressed ; ligament external ; two cardinals in each valve, laterals variable TELLINIDAE.
7. Shells thin, sub-circular, small and inflated, equivalve ; two small cardinals ; no laterals UNGULINIDAE.
8. Shells as in (7) but cardinals weaker LUCINIDAE.
9. Shells thicker, long, oval, equivalve, slightly gaping ; two prominent cardinals ; no laterals GARIDAE.
10. Shells more or less similar to the above ; hinge with three cardinals and no laterals GLAUCOMYIDAE.

C. *Hinge Pliodont (Small-sized forms).*

1. Equivalve shell ; smooth with angular dorsal margin; interior generally pearly NUCULIDAE.
2. Interior not pearly NUCULANIDAE.

List of Species of the Bombay Pelecypoda

<i>Family</i>	<i>Species</i>	<i>Occurrence</i>
1. NUCULIDAE	1. <i>Nucula layardi</i> Ad.	Occasional
2. NUCULANIDAE	1. <i>Nuculana mauritiana</i> Sow.	Occasional
	2. <i>Yoldia nicobarica</i> Brug.	Common
3. ARCIDAE	1. <i>Arca bistrigata</i> Dkr.	Plentiful
	* 2. <i>Arca requiescens</i> Mel.	Common
	3. <i>Arca inaequalis</i> Brug.	Common
	4. <i>Arca japonica</i> Reeve.	Occasional
	5. <i>Arca rhombea</i> Born.	Rare
	6. <i>Arca granosa</i> Lam.	Plentiful
	7. <i>Arca obliquata</i> Wood.	Common
	8. <i>Arca lactea</i> Lin.	Common
	9. <i>Arca tenebrica</i> Reeve.	Occasional
	* 10. <i>Arca symmetrica</i> Reeve.	Common
	* 11. <i>Arca paulucciana</i> T. confri.	Occasional
	* 12. <i>Arca tortuosa</i> Lin.	Occasional
4. GLYCYMERIDAE	* 1. <i>Glycymeris</i> (<i>Pectunculus</i>) sp.	Rare
5. MYTILIDAE	1. <i>Mytilus viridis</i> Lin.	Common
	2. <i>Modiolus emarginatus</i> Benson.	Common
	* 3. <i>Brachyodontes karachiensis</i> Mel.	Common
6. PINNIDAE	1. <i>Pinna nigra</i> Dil.	Rare
7. PECTINIDAE	1. <i>Chlamys senatoria</i> Gml.	Common
	2. <i>Chlamys singaporina</i> Sow.	Common
	* 3. <i>Chlamys tranquebarius</i> Gml.	Rare
	4. <i>Spondylus rubicundus</i> Reeve.	Common
	5. <i>Spondylus hystrix</i> .	Common
8. LIMIDAE	* 1. <i>Lima lima</i> Lin.	Rare
9. ANOMIIDAE	1. <i>Anomia achaeus</i> Gray.	Plentiful
	2. <i>Anomia aenigmatica</i> Ant.	Common
	3. <i>Placenta placenta</i> Lin.	Plentiful
0. OSTREIDAE	1. <i>Ostrea crenulifera</i> Sow.	} Very Common
	2. <i>Ostrea bicolor</i> Han.	
	3. <i>Ostrea lacerata</i> Han	

<i>Family</i>	<i>Species</i>	<i>Occurrence</i>
11. CARDITIDAE	1. <i>Cardita antiquata</i> Lam.	Plentiful
	2. <i>Cardita calyculata</i> Lam.	Rare
12. TRAPEZIIDAE	1. <i>Trapezium vellicatum</i> Reeve.	Plentiful
13. UNGULINIDAE	1. <i>Diplodonta indica</i> Desh.	Common
	2. <i>Diplodonta rotundata</i> Turton.	Common
14. LUCINIDAE	1. <i>Lucina fibula</i> Reeve.	Common
15. CHAMIDAE	1. <i>Chama macrophylla</i> Chem.	Occasional
	* 2. <i>Chama reflexa</i> Reeve.	
16. CARDIIDAE	1. <i>Cardium asiaticum</i> Brug.	Plentiful
	2. <i>Cardium latum</i> Born.	Occasional
	* 3. <i>Cardium oxygonum</i> Sow.	Rare
17. VENERIDAE	1. <i>Gafrarium divaricatum</i> Gml.	Plentiful
	2. <i>Sunetta effossa</i> Han.	Common
	3. <i>Sunetta solandri</i> Gray.	
	* 4. <i>Sunetta donacina</i> Gml.	
	* 5. <i>Sunetta scripta</i> Lin.	
	6. <i>Sunetta meroe</i> Lin.	
	7. <i>Meretrix meretrix</i> Lin.	Common
	8. <i>Dosinia pubescens</i> Phil.	
	9. <i>Dosinia gibba</i> Ad.	
	10. <i>Dosinia rustica</i> Romer.	
	11. <i>Dosinia prostrata</i> Lin.	
	* 12. <i>Dosinia excisa</i> Gml.	
	13. <i>Chione imbricata</i> Sow.	Plentiful
	14. <i>Chione layardi</i> Reeve.	Rare
	15. <i>Chione isabellina</i> Phil.	
	* 16. <i>Chione calophylla</i> Han.	
	17. <i>Katelsia opima</i> Gml.	Common
	18. <i>Katelsia marmorata</i> Lam.	
	19. <i>Venerupis macrophylla</i> Desh.	
	20. <i>Paphia malabarica</i> Dil.	
	21. <i>Paphia textile</i> Gml.	
	22. <i>Paphia indica</i> Sow.	Rare
	23. <i>Paphia cor.</i> Sow.	
	24. <i>Clementia papyracea</i> Gray.	

<i>Family</i>	<i>Species</i>	<i>Occurrence</i>
18. PETRICOLIDAE	1. <i>Petricola bipartita</i> Desh.	Rare
19. MACTRIDAE	1. <i>Macra cornea</i> Desh.	} Common
	2. <i>Macra luzonica</i> Desh.	
	* 3. <i>Macra mera</i> Reeve	
	4. <i>Macra plicataria</i> Lin.	Rare
	5. <i>Standella capillacea</i> Desh.	} Common
	6. <i>Standella pellucida</i> Gml.	
	7. <i>Raeta abercrombiei</i> Mel.	} Common
	8. <i>Lutraria planata</i> Dil.	
	9. <i>Goecella transversalis</i> Desh.	
20. DONACIDAE	1. <i>Donax scortum</i> Lin.	} Common
	2. <i>Donax incarnatus</i> Gml.	
	3. <i>Donax abbreviatus</i> Lam.	
	* 4. <i>Donax cuneatus</i> Lin.	Rare
21. GARIDAE	1. <i>Asaphis deflorata</i> Lin.	} Common
	2. <i>Soletellina atrata</i> Desh.	
	3. <i>Soletellina diphos</i> Lin.	
	4. <i>Gari malaccana</i> Reeve.	
	* 5. <i>Gari amethystus</i> Prashad.	
	6. <i>Solecurtus exaratus</i> Phil.	
	* 7. <i>Sanguinolaria hendersoni</i> Mel.	Occasional
22. SEMELIDAE	1. <i>Semele cordiformis</i> Sow.	Plentiful
	2. <i>Semele regularis</i> Smith.	Occasional
	3. <i>Abra opalina</i> Hinds.	Common
23. TELLINIDAE	1. <i>Arcopagia capsoides</i> Lam.	Common
	2. <i>Tellinella kolabana</i> Mel.	Rare
	3. <i>Apolymetis edentulus</i> Speng.	} Common
	4. <i>Gastrana polygona</i> Gml.	
	5. <i>Macoma truncata</i> Jonas.	
	6. <i>Macoma ala</i> Han.	
	7. <i>Macoma bruguieri</i> Han.	Occasional
	8. <i>Angulus rubra</i> Desh.	Common
	9. <i>Angulus rubella</i> Desh.	Rare
	10. <i>Angulus lechriogramma</i> Mel.	Common
	11. <i>Angulus thymares</i> Mel.	Rare

<i>Family</i>	<i>Species</i>	<i>Occurrence</i>
TELLINIDAE—contd.	12. <i>Angulus emarginata</i> Sow.	} Common
	13. <i>Angulus sinuata</i> Speng.	
24. GLAUCOMYIDAE	1. <i>Glaucomya cerea</i> Reeve.	Common
25. SOLENIDAE	1. <i>Siliqua albida</i> Dkr.	} Common
	* 2. <i>Siliqua radiata</i> Lin.	
	* 3. <i>Cultellus cultellus</i> Lin.	
	* 4. <i>Cultellus maximus</i> Gml.	Occasional
	5. <i>Solen truncatus</i> Sow.	} Common
	6. <i>Solen brevis</i> Han.	
	* 7. <i>Solen lamarckii</i> Desh.	
	* 8. <i>Solen linearis</i> Spg.	
26. ALOIDIDAE	1. <i>Aloidis modesta</i> Hinds.	Occasional
27. MYIDAE	1. <i>Cryptomya philippinarum</i> Ad.	Common
28. PHOLADIDAE	1. <i>Pholas bakeri</i> Desh.	} Common
	* 2. <i>Pholas orientalis</i> Gml.	
	3. <i>Martesia striata</i> Lin.	
29. PANDORIDAE	1. <i>Pandora flexuosa</i> Sow.	Common
30. THRACIDAE	1. <i>Thracia salsettensis</i> Mel.	Common
31. LATERNULIDAE	1. <i>Laternula labiata</i> Reeve.	Common

General Characters, Habits and Habitat of the Bombay Pelecypoda

1. *NUCULIDAE* :—Shells of this family are pearly white on the inside. Only one species is found in Bombay, namely, *Nucula layardi* Adams (Fig. 1. Pl. II). It has been recorded by Mel. & Ab. and Mel. & St. This shell is generally overlooked by shell-collectors, owing to its small size and slight resemblance to the shell of *Tellina lechriogramma*. Beyond Bombay it is reported to be common along the Persian Gulf, Mekran coast and Karachi.

2. *NUCULANIDAE* :—Shells of this family are not pearly on the inside. Under this family two species are recorded from Bombay.

(i) *Nuculana mauritiana* Sowerby (Fig. 2. Pl. II). Mel. & Ab. mention this species under *Leda mauritiana* Reeve. The shell is small, rounded anteriorly and pointed posteriorly. Surface with fine concentric striations. Beyond Bombay the species is widely distributed in the Indo-Pacific region.

Species marked * are recorded by us as occurring here.

(ii) *Yoldia nicobarica* Brug. (Fig. 3. Pl. II). This species is common on the Bombay shore and all along the western coast of India. The shell is smooth, greasy white in colour, somewhat elongated, and has its hinge pliodont.

3. *ARCIDAE*:—Shells with well-defined radial ribs and without any ears at the umbo. Hinge straight, long and pliodont. Ligament often external. Shells covered with bushy periostracum in life. The family is represented by 8 species recorded previously and 4 more reported by us freshly. The previously recorded species under this family are :—

- | | |
|-----------------------------------|------------------------------------|
| (i) <i>Arca bistrigata</i> Dunker | (v) <i>Arca obliquata</i> Wood |
| (ii) <i>Arca granosa</i> Lam. | (vi) <i>Arca rhombea</i> Born. |
| (iii) <i>Arca lactea</i> Lin. | (vii) <i>Arca japonica</i> Reeve |
| (iv) <i>Arca inaequalis</i> Brug. | (viii) <i>Arca tenebrica</i> Reeve |

The newly reported species from this coast are :—

- (i) *Arca symmetrica* Reeve
- (ii) *Arca requiescens* Mel.
- (iii) *Arca (Parallelopipedum) tortuosa* Lin.
- (iv) *Arca (Barbatia) paulucciana* T. confri Prashad.

A. bistrigata (Fig. 9. Pl. II) has a fairly large shell which is longer than broad. Its ventral margin is generally concave and hinge straight and long. The ribs are double or composite, with fine granular ridges. It shows variations in shape. It is found in great abundance in all stages of growth. *A. granosa* (Fig. 4. Pl. II) is a heavy shell when fully grown and has strong ribs with prominent granules. It is also found in great abundance here. *A. lactea* (*Barbatia lactea* Lin—Mel. & St.) has a regular shape showing fine, smooth ribs. It is comparatively smaller than the two previous species and is found in plenty in the same habitat as *A. bistrigata*. *Arca inaequalis* (Fig. 8. Pl. II) has a fairly large-sized shell which is somewhat square in form with lower corners rounded; ribs flattened but strong, and ridges wanting. Habitat same as that of *Arca granosa*. *Arca obliquata* (Fig. 5. Pl. II) (*Barbatia divaricata*—Mel. & St.; *Arca obtusoides* Nyst. Prashad) has a somewhat transversely oblong shell which is narrow in front and broad behind. Ribs are normal. This species is fairly common in Bombay. *Arca rhombea* bears a superficial resemblance to *A. granosa* but the ribs are coarse and without granular elevations. The shell is as long as high. This species is not common here. *Arca japonica* and *Arca tenebrica* (*Barbatia tenebrica*—Mel & St.) are only occasionally found on the Bombay shore.

Of the newly reported species *A. symmetrica* (Fig. 7. Pl. II) is very common here in the same habitat as *A. lactea*. It is a small shell with a rounded anterior and a somewhat oblique posterior end, ribs fine and 'umbones' approximate. *A. requiescens* is also a common species. The shell is very small, trapezoid in shape with narrow anterior and slightly expanded posterior end. There is a depression along the line connecting the umbo and the middle of the lower margin. The exact habitat of this species is not known, but its single valves are found cast ashore by waves. The specimens collected by us are all about $\frac{1}{2}$ " in length and coloured

white, tinged with brown. *Arca tortuosa* (Fig. 10. Pl. II) (*P. tortuosum*—Mel. & St.) is also met with occasionally and can easily be recognised by its strongly twisted shell. *Arca* (*Barbatia*) *paulucciana*—Prashad closely resembles a small *A. bistrigata* but with ventral margin convex. Only two specimens have been collected by us.

All these species of *Arca* are burrowers and they live in the littoral mud flats especially near rocks. *A. granosa* and *A. inaequalis* which grow to a fairly large size, are collected by fishermen for eating. *A. bistrigata*, *A. lactea* and *A. symmetrica* occur abundantly among the mud-covered rocks and oyster belts where they hide themselves in nooks and corners. In adaptation to such sheltering places the shells, particularly those of *A. bistrigata*, exhibit a very wide range of variation in their shape, with the result that some shells are regular while others become extremely twisted or contorted. All *Arca* species develop on their shells a kind of hairy periostracum which is greenish dark in colour and simulates the surroundings in which the specimens are found. It probably serves a protective function saving the shells from enemies as well as from the corrosive action of the brackish water.

4. *GLYCYMERIDAE*: Shells with hinge teeth strongly curved. A single specimen of *Glycymeris* (*Pectunculus*) *sp.* (Fig. 6. Pl. II) has been collected by us from Bombay. So far it has not been recorded previously. It is closely allied to *Arca* but is more round in shape. Hinge teeth are arranged in a curve. This species seems to be very rare here.

5. *MYTILIDAE*: Shells fairly thick, sub-triangular oval, elongated with anterior side narrow and posterior side broad. Umbo at the front end. The family is represented by 2 species recorded previously and one species reported by us. The species recorded previously are:—(i) *Mytilus viridis* Lin. (ii) *Modiolus emarginatus* Benson. The newly found species is:—(1) *Brachyodontes karachiensis* Mel.

M. viridis (Fig. 11. Pl. II) (*M. smaragdinus* Chem—Mel & Ab; Mel & St) occurs among rocky grounds and oyster beds round the Bombay shore. Towards the south of Bombay this wonderfully prolific species grows in immense clusters which assume a fairly large size of 8 to 10". It is an interesting sight to see such dense clusters attached to muddy rocks and easily detectable by the characteristic bright green shells which are long and tapering at the anterior and broad towards the posterior end. The flesh of this animal is deliciously eaten. *M. emarginatus* (Fig. 12. Pl. II) (*Modiola emarginata*—Mel & Ab; *Brachyodontes emarginatus*—Mel & St) is rather rare, but its shells (left valves) at different stages of growth are often found on the sea shore which easily confirm its presence here. The shell can be easily distinguished by its auricular shape and well-defined growth lines. The anterior side is pale white, while the posterior portion is purplish brown. A brown, bristly periostracum covers the shell in life.

B. karachiensis (Fig. 13. Pl. II) is found to occur here in moderately large numbers. It is smaller in size than either *M. viridis* or *M. emarginatus* but grows to a larger size than the specimen figured by Melvill and Standen. The shell is sepia-coloured and carries fine radial ridges not unlike those of *B. bilocularis*. It lives in holes and crevices in rocks which are periodically washed by the rising tide.

6. *PINNIDAE*: Under this family only one species, *Pinna nigra* Chem (Fig. 14. Pl. II) is recorded from Bombay, and that too is reported to be rare. *Pinna* is readily distinguished by its somewhat thin and large shell pointed in front, terminal umbo, toothless hinge and a small but long ligament situated in a groove. It is rather strange that this genus which is so widely distributed along the Indian sea-coast should be so rare on the Bombay beach.

7. *PECTINIDAE*: The family is represented by the two common genera *Chlamys* and *Spondylus*. Shells of *Chlamys* are oval and flat, have strong radial ribs and prominent but unequal ears at the umbo. Shells of *Spondylus* are larger, variable in shape and gibbose. Radial ribs are thin and carry irregular spines. Ears at umbo are comparatively smaller but sub-equal.

Under the genus *Chlamys* two species have been recorded :—(i) *Chlamys singaporina* Sowerby (Fig. 15. Pl. II) (*Pecten singaporinus*—Mel & Ab; Mel & St). Shells of this species at different stages of growth are common here. Young valves are small, thin and light brown in colour. Fully grown ones are fairly thick and darker in colour. (ii) *C. senatoria* Gmelin (*Pecten senatorius*—Mel & Ab; Mel & St)—Shells with beautiful colour pattern. Not commonly found in Bombay as the previous species.

In addition to these two species which are fairly large-sized, two small specimens of another species were collected by us from the Dadar beach. They are cream-coloured and mottled with sepia. In *C. singaporina* the number of radial ribs is 20/21 whereas the new specimens have only 18/19. Moreover the ears at the umbo are less prominent. The new specimens have been identified as :—(iii) *Chlamys tranquebarius* Gmelin (Fig. 16. Pl. II).

Under the genus *Spondylus*, two species have been recorded both of which are very common here. (i) *S. hystrix* Roding (Fig. 19. Pl. III) (*S. nicobaricus* Chem.—Mel & Ab; Mel & St). Shells of this species are pale brown in colour; fairly large in size with spiny ribs. The spines vary both in size and form, those near the ventral margin are larger. (ii) *S. rubicundus* Reeve (Fig. 20. Pl. III) has shells which are reddish in colour. Irregular spines characteristic of the previous species are absent. Both these species are found attached to muddy rocks near low tide mark. *S. hystrix* is more common than *S. rubicundus*.

Included in the family of Pectinidae is another genus *Plicatula*, shells of which superficially resemble a small *Spondylus* but are without ears at the umbo. The occurrence of this genus in Bombay does not appear to have been recorded so far, but we have been fortunate to collect from the littoral rocks at Bandra two or three shells which are white in colour and have the surface rugose. We have provisionally placed these shells under the species: *P. ramosa* Lam (Fig. 17 & 18. Pl. II), subject to confirmation.

8. *LIMIDAE*: This family is not recorded from Bombay before. We have however come across a single shell of *Lima lima* Lin. = *squamosa* Lam. (Fig. 21 Pl. III) from the Bandra beach. The shell is white in colour, radially ribbed, with a small ear at the umbo and agrees in all details with the figures given by Prashad (Siboga Expedition).

9. **ANOMIIDAE**: Shells ostreiform, thin and irridiscent, hinge teeth absent. Under this family two genera *Anomia* and *Placenta* are very common in Bombay. Both when young resemble each other in their general shape and architecture, but can be distinguished from each other by the following characters. In *Anomia* the left valve is somewhat gibbose and irregular and completely covers the right one which is much thinner and closely fixed to the substratum. In *Placenta* both the valves are larger and flatter and do not differ much from one another.

Under this family the following three species are recorded from Bombay. (i) *Anomia achaeus* Gray (Fig. C. Pl. I) (ii) *Anomia* (*Aenigma*) *aenigmatica* Ant. (iii) *Placenta placenta* Lin. (Fig. E. Pl. I) (*Placuna placenta* —Mel & Ab; *Placenta orbicularis* Retz. Mel & St). All these three forms are sedentary and live attached to the sides of mud-covered rocks. *A. achaeus* and *A. aenigmatica* (the former light brown and the latter rosy in colour) are found in large numbers on the upper parts of rocks or adhering to the shells of other molluscs including *Placenta*. *P. placenta* thrives near the base of rocks in the mud banks at low water mark.

Anomiidae are preyed upon by carnivoran whelks like *Purpura*, *Bursa*, etc. A *Purpura* crouches near an Anomiid and lies in wait until the latter opens its valves when abruptly the former inserts its own shell edge as a wedge between the valves, and by means of its extensile proboscis eats up the flesh of the victim. It does not however appear to be an easy job for the whelk to eat an Anomiid, because the bivalve shell, although apparently thin and weak, is at the same time tough and leathery in the living condition and cannot be opened by the ordinary efforts of the whelk. Moreover at the slightest disturbance the Anomiid at once closes its shell valves tight, withdraws its mantle, contracts its visceral mass and confines itself to the central part of the shell. The irridiscent nature of the valves may have some protective significance.

Both *A. achaeus* and *P. placenta* are widely distributed species throughout the Indo-Pacific region. The large, translucent, disc-like shells of *P. placenta* are used in China, Japan and also in Goa for panelling windows and hence the name 'window pane oysters'. In Bombay garden fanciers collect these shells in large numbers for fringing the garden pathways.

10. **OSTREIDAE**: Shells inequivalve, fixed by the left valve, form irregular, no hinge teeth. Under this very widely distributed family of great economic importance, Bombay has only the following three species recorded so far:—(i) *Ostrea crenulifera* Sowerby (ii) *Ostrea bicolor* Hanley (iii) *Ostrea lacerata* Hanley. All these three species are very common on rocks, piers and such other substrata near high water mark along the Bombay shore.

O. crenulifera (Fig. A. Pl. I) is roughly oval, with the left valve fixed and cup-shaped, and has its rim thrown into a number of folds. The right valve is somewhat thinner and flatter and the colour is generally greyish white but varies according to the nature of the surrounding water. Specimens nearer the creeks are less brightly coloured than those away towards the open sea. *O. crenulifera* does not grow much in size. Its closely fitting, interlocking valves render it difficult to extract its flesh

easily. For these reasons this oyster is not of much economic importance. In *O. bicolor* (Fig. D. Pl. I) the shell margin is more or less wavy and the surface tinged with pink and blue. It is larger than *O. crenulifera* and is commonly eaten. *O. lacerata* (Fig. B. Pl. I) occurs in dense clusters growing vertically and attached to piers and rocks. Its valves are spoon-shaped and thin with sharp margins. The colour is greyish pink, sometimes mottled with white.

Closely allied to *O. crenulifera* is found another species of oyster, having its marginal folds more pointed and elongated and tinged with pink. It appears to be *O. crista galli* or the "cockscorn" oyster.

In the vicinity of the Bandra creek many fishermen and women live on collecting and selling oyster flesh from that locality. The oyster beds there would have given a better yield, but for the abundance of the habitual enemies like *Mytilus*, *Murex*, *Purpura*, *Cantharus*, etc. which flourish on the muddy rocks and prey upon the oysters.

The larvae of oysters sometimes attach themselves to shells of other animals like *Gyrenium*, *Planaxis*, *Nerita*, etc. and begin to grow around them into queer forms. We have secured a shell of *Gyrenium tuberculatum* around the mouth of which an *O. crenulifera* (?) has grown in such an attractive way as to resemble a perfect flower.

11. *CARDITIDAE*: Shells thick and equivalve with radiating costae. Pallial sinus absent. Hinge with one or two oblique cardinal teeth and one or two rudimentary laterals. The family is represented by a single genus *Cardita* under which there are two species recorded from the Bombay shore. (i) *C. antiquata* Lam. (ii) *C. calyculata* Lam.

C. antiquata (Fig. 26. Pl. III) (*Cardita bicolor*—Gravely) is very abundant not only here but all along the east and west coasts of India. Its shell is triangularly oval in shape with umbo more or less central and slightly twisted anteriorly. The ribs are strong and regular with red or orange brown patches. The anterior ribs are granulated. Specimens of different sizes are obtainable here at all times, some with a few colour patches, some with innumerable dots covering the surface, and others with practically no dots at all. The animal lives buried in muddy sand at varying depths and is sometimes collected by fishermen along with other cockles for eating purposes. *C. calyculata* (Fig. 27. Pl. III) (*Begonia variegata* Brug-Gravely; *Cardita* (*Arcinella*) *variegata*—Prashad) is very rare in Bombay but generally common along the coasts of Ratnagiri, Goa and Madras. Its shell is elongated with anterior umbo, longer than high and coloured brown.

12. *TRAPEZIIDAE*: The Bombay species representing this family is *Trapezium vellicatum* Reeve. *T. vellicatum* (Fig. 25. Pl. III) (*Cypricarda vellicata* Mel & Ab; *Libitina vellicata*—Mel & St) occurs in plenty in the cavities of oyster beds and stones between high and half water-marks. The population of this species shows an increase during the monsoon months of June, July and August, as during this period all stages of growth are represented in abundance. Generally speaking *T. vellicatum* has a regular shape not very different from that of an *Arca*, longer than high with an anterior umbo; but owing to mechanical

causes depending upon the space or nature of the cavities in which it resides, the shell also undergoes some modifications by getting contorted or twisted a little behind the lower front angle. *T. vellicatum* is widely distributed along the coast of the Indo-Pacific region.

13. *UNGULINIDAE*: Shells thin, small, equivalve and sub-circular, no lateral teeth, cardinals much reduced. Two species belonging to this family are commonly found in Bombay. (i) *Diplodonta indica* Desh (Fig. 24. Pl. III), (ii) *D. rotundata* Turton (Fig. 23. Pl. III). Both these species are found living in sandy mud sometimes several feet deep. Their shells are common on the beach especially along with scum and weeds. Shells of both are globular; those of *D. rotundata* more gibbose and slightly thicker.

14. *LUCINIDAE*: The Bombay representative of this family is *Lucina fibula* Reeve (Fig. 22. Pl. III) (*Codakia divergens* Phil. Prashad). This species is widely distributed throughout the tropics. It resembles *Diplodonta* in shape but is less globose and does not possess cardinal teeth. The shell is somewhat thick, with growth lines more pronounced near the ventral margin.

15. *CHAMIDAE*: There is only one species found on the Bombay coast, namely *Chama macrophylla* Chem. (Fig. 31. Pl. III). This species is not very common in Bombay. Its valves are occasionally found along the shores. It lives attached to sides of rocks below half tide marks. The shell is roughly oval resembling a *Plicatula* or *Spondylus* due to the presence of innumerable, irregular crests along the transverse growth lines. The shell can however be distinguished by the somewhat twisted umbo near which it is invariably tinged deep orange.

Probably another species also occurs here, as we have secured an imperfect specimen from the Bandra beach, which has on its surface definite spicules instead of pleated crests. The umbo is somewhat more spiral than in *C. macrophylla*. The specimen agrees in details with *Chama reflexa* Reeve (Gravelly).

16. *CARDIIDAE*: Shell oval, radially ribbed, hinge with two prominent lateral teeth and two cardinals of which one is small. Arrangement of teeth in both the valves similar. The family is represented by the type genus *Cardium* under which two species have been recorded. (i) *Cardium asiaticum* Brug. (ii) *Cardium latum* Born.

C. asiaticum (Fig. 28. Pl. III) (*C. coronatum* Speng—Mel & Ab) is more common of the two and occurs in considerable numbers. The shell is round and inflated, with ribs strong and regular, and the umbo central. The umbo and the shell margin are invariably tinged pink while fresh. In some cases the ribs are crested especially near the ventral margin, and based on this feature some authors group the crested variety under a separate species *C. coronatum*. *C. asiaticum* grows to a fairly large size, and is extensively collected by fishermen from knee-deep mud where it thrives. *C. latum* (Fig. 30. Pl. III) (*C. setosum* Redfern-Gravelly) is a less common species. Its shell is longer than wide, with umbo anterior and covered with bristly epidermis when fresh. This shell is found to occur in sandy mud-layers surrounding rocks.

In addition to these two species we have secured a single specimen of a new species which is broader than long and less inflated than *C. asiaticum*. The ribs are fine and numerous and the surface colour somewhat grey. The specimen has been identified as *C. oxigonum* Sow. (Gravely) (Fig. 29. Pl. III).

17. *VENERIDAE*: Shells solid, equivalve, hinge with three cardinals, laterals variable, pallial sinus present. Under this universally distributed and large family at least *nine genera* are well-represented in Bombay. All the members are purely littoral in habitat, living at various depths in the sand or mud banks or on the sides of rocks between the tide marks. Bathymetrically it is not possible to assign any fixed depth or stratum for the several genera. One may however presume that from the gravitational point of view, the heavier forms dwell deeper in the sand than the lighter ones, but the reverse arrangement also is often met with. Veneridae, although they possess shells comparatively thicker than in Tellinidae and Ungulinidae which as a rule have thin shells, are found to abound nearer the surface. Donacidae live at a level lower than Veneridae, and Tellinidae thrive still deeper down. Therefore apart from the *weight* factor, the shape and structure of the shell, the foot and the siphon also determine the special domain of the different kinds of bivalves. Anyway by scooping out the mud or sand, to a maximum depth of three feet in the littoral region, one is sure to secure ample specimens of most of the species of Veneridae occurring in this coastal region.

Under this family the following *genera* are represented in Bombay and their chief identification characters are as below :—

1. *Gafrarium* Shell thick, moderately convex, round with well-defined hinge teeth, shell surface concentrically and radially sculptured and ornamented with orange-brown colour patches, lunule behind the umbo flattened and pallial sinus not much pronounced.

2. *Sunetta* Shell solid, longer than high, anteriorly narrow and rounded, posteriorly slightly truncate, shell surface smooth or only concentrically striated, lunule depressed and narrow and pallial sinus deeper than in *Gafrarium*.

3. *Meretrix* Shell solid, thick, triangular oval, surface glossy and polished, no striations, lunule not flat, pallial sinus not deep.

4. *Dosinia* Shell thinner than the above genera, as a rule circular, umbo narrow and inclined forwards, lunule short but well defined, surface finely concentrically striated and pallial sinus deep.

5. *Chione* Shell roughly triangular oval, umbo slanting more towards the anterior side than in *Meretrix*, surface generally sculptured and pallial sinus well-developed.

6. *Katelsia* Differs from *Chione* in the absence of strong sculpture and having a polished surface.

7. *Venerupis* Shell rectangular, with anterior umbo and crests along growth lines.

8. *Paphia* Shell transversely oval, hind end somewhat narrowly rounded, hinge margin thinner and shell longer than *Katelysia*.

9. *Clementia* Shell thin and fragile with wavy concentric striations.

Under the genus *Gafrarium* a single species is commonly found here which is widely collected for edible purposes. *G. divaricatum* Gmelin (Fig. 32. Pl. III) (*Circe divaricata* Chem—Mel. & Ab.) has a thick shell of moderately large size with radiating ridges arranged in a peculiar fashion. The ribs or ridges starting from the margin converge not at the umbonal end but end in the median line stretching from the umbo to the ventral margin.

Genus *Sunetta* is represented here by at least 5 species :—

- | | |
|--------------------------------|-------------------------|
| (i) <i>S. effossa</i> Hanley | } Recorded by Mel & Ab. |
| (ii) <i>S. solandri</i> Gray | |
| (iii) <i>S. meroe</i> Lin | Recorded by Mel & St. |
| (iv) <i>S. donacina</i> Gmelin | } Reported by us. |
| (v) <i>S. scripta</i> Lin | |

S. effossa (Fig. 35. Pl. III) (*Meroe effosa*—Mel & Ab.) is concentrically striated with purple chevron patches when young. Posterior margin more or less rounded. *S. solandri* (Fig. 37. Pl. IV) (*Meroe solandri*—Mel & Ab.) resembles the above, but the surface is smooth. It grows heavier and more gibbose, with the result that the well-developed ones have an oval shape. *S. meroe* (Fig. 33. Pl. III) resembles *S. effossa* but is a little longer than the latter and has its posterior margin somewhat truncate. The web markings are closer and orange-coloured. *S. donacina* Gmelin (Fig. 36. Pl. IV) with its concentric striations resembles *S. effossa* in the younger stages but grows considerably larger and thicker. The striations disappear with growth, so much so that the adult form looks just like *S. solandri*. Dr. Gravely gives the following synonyms to this species :— *S. donacina* (Gmelin = *birmanica* Phil + *seminuda* Ant + *effosa* Hanley) *Meroe seminuda* + *effosa* Reeve (Gravely pp. 50 & 99). *S. scripta* (Fig. 34. Pl. III), a few specimens of which were picked up by us from the Dadar beach, has a shell resembling *S. solandri* but definitely smaller and flatter, and with fine, bright chevron pattern. Two more species of *Sunetta* are also found to be common here. Anyway this genus of Bombay requires a further careful survey in order to prepare an all-comprehensive list of all the species occurring here.

Genus *Meretrix* is represented here by a single species, namely, *M. meretrix* Lin. (Fig. 38. Pl. IV) which is very abundant in all the following colour varieties :—*M. meretrix* : var. *morphina* Lam. ; *castanea*

Lam; *petechialis* Lam; and *impudica* Lam—(Mel & Ab.). Some authors consider these varieties as separate species. *M. meretrix* is largely collected for food purposes.

Genus *Dosinia* is represented by 4 species recorded previously and one species reported by us. The species previously recorded are:—(i) *D. pubescens* Phil (ii) *D. gibba* Ad. (iii) *D. rustica* Romer and (iv) *D. prostrata* Lin. The newly reported species is (v) *D. excisa* Gmelin.

D. pubescens (Fig. 41. Pl. IV) is smaller than the other species, with a fairly smooth surface especially near the umbo where it is tinged light pink. *D. gibba* differs from others in having a somewhat globose shell. *D. rustica* has the shell surface rough. In *D. prostrata* (Fig. 39. Pl. IV) the umbo is more markedly bent forwards and the posterior margin sometimes crested. *D. excisa* (Fig. 40. Pl. IV) can easily be distinguished by its less bent umbo, long lunule and somewhat triangular oval shape. *Dosinia* thrives well at a depth of about a foot in the muddy sand and is commonly eaten.

Under the genus *Chione* 3 species have been recorded:—(i) *C. imbricata* Sowerby (ii) *C. layardi* Reeve & (iii) *C. isabellina* Phil. *C. imbricata* (Fig. 43. Pl. IV) (*Venus imbricata* Mel & Ab.) is a tiny shell resembling a miniature *Cardita antiquata*, coloured grey or white with radially crested ridges. It occurs in great abundance in the shore sand. *C. layardi* (*Venus layardi*—Mel & Ab.) and *C. isabellina* (*Venus isabellina*—Mel & Ab; *Anaitis isabellina*—Mel & St.) are not commonly found on this shore.

Besides the above three species recorded by Melvill and Abercrombie, we have collected a new specimen, slightly larger than *C. imbricata*, and having concentric crests. Its habitat is on the littoral rocks. The specimen has been identified as *C. calophylla* Phil (Fig. 42. Pl. IV) (Prashad, pp. 258-259).

Genus *Katelsysia* is represented by two very abundant species:—(i) *K. (Eumarcia) opima* Gmelin & (ii) *K. (Hemitapes) marmorata* Lam. *K. opima* (Figs. 44 & 45. Pl. IV) (*Venus pinguis* Hinds—Mel & Ab; *Tapes pinguis* Reeve—Mel & St.) with its glossy smooth surface bears a close resemblance to *M. meretrix*. Some varieties of *K. opima* are brown, some black and some carry beautiful designs. It thrives well in mud banks along with the other species *K. marmorata*. *K. marmorata* (Fig. 47. Pl. IV) (*Venus radiata* Chem = *Tapes marmorata* Reeve—Mel & Ab; *Tapes radiata* Chem—Mel & St; *Paphia marmorata* Reeve-Gravelly) resembles genus *Paphia* when young, but when fully grown, it becomes thicker and gibbose and assumes the typical *Katelsysia* form. The shell surface is more or less concentrically grooved and looks as if it is varnished. The tip of the umbo is sometimes tinged pink or blue.

Genus *Venerupis* is represented by a single common species:—*V. macrophylla* Desh (Fig. 50. Pl. IV). It thrives in rock-holes in the same way as *Trapezium vellicatum* with which it bears some resemblance in shape and colour. The shell is rectangular, not exceeding 2" in length, cream-coloured, ridged radially and finely and with well-developed, concentric crests. This species is extensively distributed in the Indo-Pacific region.

Under the genus *Paphia* the following 4 species are recorded :—

- (i) *P. malabarica* Dil (ii) *P. textile* Gmelin (iii) *P. indica* Sow. and (iv) *P. (Protapes) cor.* Sow.

P. malabarica (Fig. 46. Pl. IV) (*Tapes malabarica* Chem—Mel & Ab) is a somewhat gibbose shell when fully grown with well-developed concentric striations. The colour is greyish cream. *P. textile* (Fig. 49 Pl. IV) (*Tapes textrix* Chem—Mel & Ab ; Mel & St) is an elongated smooth and polished shell with darkish or greyish chevron markings on a thick creamy background. No concentric striations are present. In some specimens the polish is very much reduced along with the web markings, and the growth lines are pronounced in the form of wavy striations. Some authors consider these forms as a separate species viz. *P. undulata* Born (*Tapes undulata* Born—Mel & St). *P. indica* (Fig. 48. Pl. IV) (*Tapes indica* Sow—Mel & Ab ; near or = *Paphia bruguieri* Hanley—Prashad pp. 242 & 243) is an elongate shell with a broad posterior side. The surface colour is brownish white. Concentric and radial striations are present. *P. (Protapes) cor.* (*Venus cor.*—Mel & Ab ; *Tapes cor.*—Mel & St) is a somewhat large gibbose shell, generally brown in colour. *P. malabarica*, *P. textile* and *P. undulata* are very common, but *P. indica* and *P. cor* are rather rare.

Genus *Clementia* is represented by a single species, *Clementia papyracea* Gray. It is a widely distributed species, but is not very common in Bombay, probably on account of its extreme fragility.

18. **PETRICOLIDAE** : Shell oval, slightly gaping behind, two or three cardinals, no laterals, pallial sinus well-marked. This family is poorly represented in Bombay ; only one species has been recorded viz :—*Petricola bipartita* Desh.

19. **MACTRIDAE** : Shells equivalve, triangular oval, hinge with ligament in an internal fossette, another portion external, a bifurcated cardinal tooth in the left valve fitting into a branching tooth in the right valve, laterals present. Under this family 5 genera are represented in Bombay. Their characters are given below :

1. *Macra*. Shell generally triangular oval, slightly longer than high, ligament separated from its nodule by a calcareous ridge.

2. *Standella*. Shell elongated with deep pallial sinus, teeth arrangement similar to that of *Macra* but laterals are nearer to the cardinals.

3. *Rasta*. Shell thin and fragile, transparent concentrically grooved, cardinals weak and laterals rudimentary.

4. *Lutraria*. Shell thin and long, flat, umbo small near the anterior end, upper margin more or less parallel to lower margin, lateral teeth suppressed.

5. *Coccella*. Shell somewhat thick, more or less triangular and elongated, medial umbo, nodule spoon-shaped.

Under *Macra* three species are recorded from Bombay :— (i) *M. cornea* Desh (ii) *M. luzonica* Desh and (iii) *M. plicataria* Lin. (*Macrinula plicataria* Lin., Mel and St.) All these species attain a fairly large size and resemble each other especially in the younger stages. In *M. cornea* (Fig. 51. Pl. IV) the surface is concentrically grooved and the ventral margin is more round than in *M. luzonica*, which thus gives it a gibbose appearance. In *M. plicataria* the shell is moderately long, and concentric waves are noticeable especially near the umbo and in the front area. *M. plicataria* is rather rare in Bombay but very common in Madras.

Apart from these species we have also come across specimens of *Macra mera* Reeve (Fig. 53. Pl. IV) and *M. cygnus* Gmelin on this shore. In *M. mera* the colour is light brown but from the umbo white patches radiate towards the lower margin. *M. cygnus* is a small triangular shell violet in colour.

Under the genus *Standella* two species are plentiful here. (i) *S. capillacea* Desh (Fig. 54. Pl. IV) (*Harvella capillacea*—Mel and Ab) (ii) *S. pellucida* Gmelin (Fig. 52. Pl. IV) (*Harvella pellucida*—Mel and Ab.).

In both the species the shells attain a large size and are rugose white on the exterior. In *S. capillacea* the upper margins lying anterior and posterior to the umbo are more or less equal in length, whereas in *S. pellucida* the posterior margin is longer. Shells of these bivalves are very common along the beach throughout the year. Young shells are transparent, but the grown up ones are thick. *Standella* lives in slimy mud at varying depths. *S. capillacea* has been recorded from Mekran coast, Karachi and also from south of Bombay upto Goa and Panjim. *S. pellucida* is common in Bombay, Ratnagiri and Madras.

Genus *Raeta* is represented by a single species called *Raeta abercrombiei* Mel (Fig. 55. Pl. IV) Valves of this extremely delicate shell are often attached to sea weeds cast ashore by sea-waves.

Under genus *Lutraria* the species recorded from Bombay is *Lutraria planata* Dil (Fig. 56. Pl. IV). The shell is concentrically corrugated. It resembles closely *Lutraria philippinarum* Desh. (Prashad pp. 211-222). This species is not so rare here as remarked by Mr. Abercrombie. Its shell is found on the shores of Bombay in fairly large numbers.

The Bombay representative of the genus *Coecella* is *C. transversalis* Desh (Fig. 57. Pl. V) (*Lutraria transversalis*—Mel and Ab.) The shell is white but covered with a brownish green epidermis as in the case of fresh water mussel. It is found in great abundance here on mud flats near rocks.

20. *DONACIDAE* : Shell more or less triangular, margin anterior to the umbo longer and less oblique than the posterior, anterior side rounded, posterior flat, pallial sinus deep. The three common species in Bombay are :—(i) *Donax scortum* Lin (ii) *Donax incarnatus* Gmelin (iii) *Donax abbreviatus* Lam.

D. scortum (Fig. 60. Pl. V) is readily recognized by its well-defined keel extending obliquely from the umbo to the sharply pointed hind angle, radial ridges and concentric striations which are often crested, dark brown periostracum, and purple interior. Soon after the withdrawal of the tide, one can see members of this species ploughing their way through mud and burying themselves. A specimen was once observed being swallowed by a large sea-anemone, while the former was carelessly moving over the latter's oral region. *D. Scortum* is widely distributed along the coasts of India. *D. incarnatus* (Fig. 63. Pl. V) (*D. incarnatus* = *dysoni* Desh—Mel and Ab) is a very abundant species. Its shell is thin, small and glossy, coloured prettily in pink, cream or purple. The hind margin is somewhat vertical to the lower margin. *D. abbreviatus* (Fig. 64. Pl. V) possesses a shell of about $1\frac{1}{2}$ " long and 1" wide, thick and marked by growth lines. Sometimes pure white inside and out, and sometimes deep purple inside and brown outside, with all intermediate variations. This species is very common here, living a few inches deep in mud layers. It is collected in large numbers for food purposes.

In addition to these three species, a shell of *D. cuneatus* Lin. (Fig. 61. Pl. V) was collected by us from the Bombay shore. It is greyish blue in colour, slightly larger but thinner than *D. abbreviatus* and has both fine transverse and radial ridges confined to the hind region.

21. **GARIDAE**: Shell long oval, ligament external and generally mounted on a ledge margin with two cardinals but no laterals, pallial sinus deep. The family is represented by 5 species recorded previously and 2 species reported by us. The species previously recorded are :—(i) *Asaphis deflorata* Lin. (ii) *Soletellina atrata* Desh. (iii) *Soletellina diphos* Gmelin. (iv) *Solecuretus exaratus* Phil. (v) *Gari malaccana* Reeve. The species newly reported by us are :—(i) *Gari amethystus* Prashad (ii) *Sanguinolaria hendersoni* Mel and St.

A. deflorata is a fairly large-sized elongated shell, thick and cream-coloured on outside with longitudinal ridges ; interior pinkish purple. *S. atrata* (Fig. 62. Pl. V) (*Solenotellina* (*Psammobea*) *atrata* Desh—Mel. and Ab.) is a beautiful dark-blue shell commonly found on the shore. *S. diphos* (Fig. 58. Pl. V) is a large and elongate blue shell with two white rays towards the posterior end radiating from the umbo to the ventral side. *S. exaratus* is an elongated parallel-sided shell, somewhat large and thick, and widely gaping at the ends. *G. malaccana* (*Psammobea malaccana* Reeve = *pallida* Desh—Mel. and Ab.) has some resemblance to the above species but pale white in colour ; ventral margin more rounded and hind end truncate. *G. amethystus* (Fig. 59. Pl. V) is an elongate pale bluish shell obliquely truncate behind and covered with green periostracum. On the surface fine growth lines at irregular spaces are noticed. *S. hendersoni* (*Tellina nobilis*—Gravely) resembles a small *S. atrata* but pink in colour. Shells of most of these species are found washed ashore along with sea-weeds and scum.

22. **SEMELIDAE**. The two genera recorded under this family in Bombay are *Semele* and *Abra* : the former having the shell thick and subcircular, and the nodule socket not projecting inside ; and the latter having the shell thinner and elongate, and the nodule socket more or less projecting.

Under the genus *Semele* the species recorded are:—(i) *Semele cordiformis* Sow and (ii) *Semele regularis* Sow.

S. cordiformis (Fig. 66. Pl. V) has a circular shell with medial umbo and faint radial striations. Fresh specimens are tinged light pink. It occurs in great abundance in mud flats along with *Dosinia* which it resembles closely in size and shape. It is collected in large numbers for eating purposes. *S. regularis* is a slightly longer species with less number of striations. It is not common on the Bombay shore.

Genus *Abra* has only one representative namely :—*A. opalina* Hinds (*Theora opalina* Hinds—Gravely). Its shell is thin and white, anteriorly rounded and posteriorly tapering; very common on the shore along with weeds and scum.

23. **TELLINIDAE** : Popularly called “paper shells.” The valves are generally of thin consistency varying in size and shape. Right valve usually with lateral teeth as well as cardinals. Pallial sinus large. Various genera are included under this immense family but some authors reunite the various genera into the type genus *Tellina*, as the differentiating characters employed for division are of minor value. The following 13 species are recorded from Bombay :—

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|------------------------------------------|----------------------------------------|
| (i) <i>Arcopagia capsoides</i> Lam. | (viii) <i>Angulus rubra</i> Desh. |
| (ii) <i>Tellinella kolabana</i> Mel. | (ix) <i>Angulus lechriogramma</i> Mel. |
| (iii) <i>Apolymetis edentulus</i> Speng. | (x) <i>Angulus emarginata</i> Sow. |
| (iv) <i>Gastrana polygona</i> Gmelin. | (xi) <i>Angulus sinuata</i> Speng. |
| (v) <i>Macoma ala</i> Hanley. | (xii) <i>Angulus rubella</i> Desh. |
| (vi) <i>Macoma truncata</i> Jonas. | (xiii) <i>Angulus thymares</i> Mel. |
| (vii) <i>Macoma bruguieri</i> Hanley. | |

A. capsoides (Fig. 71. Pl. V) (*Tellina capsoides* Lam—Mel & Ab. ; *Tellina* (*Arcopagia*) *capsoides*—Mel & St. ; *Tellina pristis* Lam—Prashad pp. 186 & 187) is a common shell of moderate size, with medial umbo, white in colour and with concentric striations which form sharp crests along the oblique hind margin. Besides Bombay this species is common on the Red Sea coast, Karachi, Goa, Malabar and Madras.

Tellinella kolabana (*Tellina kolabana*—Mel & Ab ; *Tellina* (*Telinella*) *Kolabana*—Mel & St) is a small but fairly thick shell, faintly yellowish pink in colour which is more prominent near the umbo. Growth lines concentric which become more pronounced along the hind margin. Its shells are not very common.

Apolymetis edentulus (*Gastrana* (*Metis*) *edentula*=*angulata* Chem—Mel and St ; *Tellina angulata* Reeve—Gravely) is a fairly large shell distinguished by its hind margin which is rounded, more or less wrinkled and separated from the rest by a keel. Very common here and also in Karachi and Goa.

Gastrana polygona (Fig. 68. Pl. V) (*Gastrana* (*Metis*) *polygona* Chem—Mel & Ab ; *Tellina multangula* Gmelin=*polygona* Reeve—Gravely) Shell large and thick ; surface rough, growth lines coarse, hind side folded and truncate and umbo sub-medial. The shell valves are quite common on the shores. Some of the valves are tinted yellow inside, while others are slate-coloured.

Macoma truncata (Fig. 67. Pl. V) (*Tellina* (*Macoma*) *truncata*—Mel & St) has a large white shell posteriorly oblique and wavy and anteriorly somewhat rounded. Growth lines are prominent near the ventral margin. It occurs in great abundance on this coast.

Macoma ala (Fig. 65. Pl. V) (*Tellina* (*Homala*) *ala*—Mel & Ab) resembles the above species but smaller in size. Surface finely concentrically grooved. Posterior end folded to form a wing-like projection. Occurs in plenty in the littoral mud-flats.

Macoma bruguieri (Fig. 69. Pl. V) (*Gastrana bruguieri*—Mel & Ab ; *Tellina bruguieri* Reeve—Gravelly). Shell somewhat thick, hind upper margin more or less rounded. This species has a wide distribution, but it is not found in plenty here.

Angulus rubra (Fig. 72. Pl. V) (*Tellina* (*Angulus*) *rubra* Desh=culta Han.—Mel & Ab ; *Tellina cuspis* Reeve—Gravelly) is a very common shell found in shingle generally after the storm. The shell resembles *M. ala*, but slightly smaller, deep pink in colour and the posterior wing not prominent.

Angulus lechriogramma (Fig. 73. Pl. V) (*Tellina* (*Moera*) *lechriogramma*—Mel & Ab) has some superficial resemblance to a small *Donax incarnatus*. It is white silky in colour and finely, concentrically grooved.

Angulus emarginata (*Tellina emarginata*—Mel & Ab ; *Tellina* (*Tellinides*) *emarginata*—Mel & St ; *Tellina emarginata*—Prashad). A very common shell, elongated, broadly truncate behind, fairly thick, surface with markings of growth lines, margin and the inside tinged with pink.

Angulus sinuata (Fig. 70. Pl. V) (*Tellina* (*Homala*) *sinuata*—Mel & Ab ; *Tellina* (*Tellinides*) *sinuata*—Mel & St ; *Tellina sinuata* Reeve—Gravelly). Its shell resembles that of *A. emarginata* ; a hollow posterior and slightly broader. A very common species.

Angulus rubella (*Tellina rubella*—Mel & Ab) and *A. thymares* Mel (*Tellina* (*Tellinides*) *thymares*—Mel & St) although recorded by Abercrombie have not been seen by us on the Bombay shore so far.

Members of *Tellinidae*, although they possess comparatively light shells, are found to dwell deeper in mud or sand than the cockles, but sometimes after the waves have retarded they come up to the surface. Living specimens are occasionally found in mud flats lying on their sides and imbibing water containing green volvocales and diatoms. In this exposed position some birds like gulls and crows pick them up for food. Sometimes a sudden wave dashes them against the shore but the majority manage to slip down into the mud before the tide returns and thus save themselves. Once while attempting to catch an *A. capsoides* from the surface of a mudflat, the shell abruptly jerked from the hands and made a swift darting glide covering a distance of one yard or more and disappeared in the slime.

24. *GLAUCOMYIDAE*: Shell elongate and thin, pallial sinus well-marked, hinge with cardinals and no laterals. The Bombay species pertaining to this family is *Glaucomya cerea* Reeve. This species is stated to occur here in plenty in brackish waters. Its shell has a superficial resemblance to that of the common fresh water mussel, *Unio* or *Anodonta*.

25. *SOLENIIDAE* : Easily recognised by the long but equivalve shells, narrow and gaping at both ends. The umbo is considerably flattened, the ligament is external and the shell surface generally covered with periostracum. Under this family three *genera* are found in Bombay :—

1. *Siliqua*. Shell thin, transparent and fragile, long oval with an internal ridge passing from the hinge teeth to the lower margin.

2. *Solen*. Shell thicker, greatly elongated, straight and truncate at both ends ; one tooth in each valve.

3. *Cultellus*. Shell thin resembling a small *solen* but with ends rounded and lower margin curved upwards.

Under *Siliqua* two species commonly found in these parts are (i) *S. albida* Dunker (ii) *S. radiata* Lin. *S. albida* (*Machaera albida*—Mel & St) has a thin white shell with the upper and lower sides approximately parallel and ends rounded. The shell is very common here. *S. radiata* (Fig. 74. Pl.V) (*Machaera polita*—Mel & St): Fully grown shells are not common but young ones are found in plenty along the coast. The transparent purplish tint and the two or three expanding colourless rays radiating from the umbo marginwards enable this species to be easily spotted out.

Genus *Solen* is represented by 2 species recorded previously and 2 more species reported by us.

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| (i) <i>S. truncatus</i> Sow. | } Recorded previously. |
| (ii) <i>S. brevis</i> Hanley. | |
| (iii) <i>S. lamarckii</i> Desh. | } Reported by us. |
| (iv) <i>S. linearis</i> Speng. | |

S. truncatus (Fig. 80. Pl. VI) has its shell very long and with parallel upper and lower margins and abruptly truncate behind. Pinkish purple bands are strongly developed. *S. brevis* is a smaller species covered with greenish periostracum. Pink colouration is not prominent. *S. lamarckii* has a shell similar to that of *S. truncatus* but not so long (shell about 4 to 5 times as long as broad). *S. linearis* (Fig. 78. Pl.V) is a narrow long shell, about 10 to 12 times as long as broad. Pink colour pattern prominent.

Genus *Cultellus* is represented by the species *C. cultellus* Lin (Fig. 79. Pl. V). It has a thin elongated shell, rounded at both ends. Lower margin curved upwards.

Probably another species *C. maximus* Gmelin (*lacteus* Speng), having a comparatively large white shell also occurs in Bombay. A fine specimen of this species collected from the Bombay Harbour is among the collections of the Prince of Wales Museum, Bombay.

All members of *Solenidae* live deeply buried in mud vertical burrows. They are typically laminarian. Sometimes at low tide the *Solen* pro-

trudes its long siphons above the mud surface but at the slightest disturbance it squirts out a stream of water through its siphon, and with its strong pointed nimble foot, propels itself down to its deep retreat. Fishermen catch the smaller species for bait and the larger ones for food purposes.

26. *ALOIDIDAE* : Under this family the only species represented in Bombay is *Aloidis modesta* Hinds (*Corbula modesta*—Mel & Ab ; Mel & St). The shell is somewhat oval with concentric striations and covered with green periostracum. This species does not seem to be common here.

27. *MYIDAE* : Valves thin and somewhat unequal and gaping behind ; internal ligament nodule attached to a projection of margin of left valve which fits beneath the margin of right valve. The only species recorded from Bombay and which is commonly washed to the shores by waves is *Cryptomya philippinarum* Ad. (Fig. 77. Pl. V) (*Mya philippinarum* Reeve—Gravelly). The shell can be recognised by its fragility, white colour, concentric striations in front and radial striations crossing over them on the hind side.

28. *PHOLADIDAE* : Shell more or less gaping, thin but ribbed, dorsal margin in part reflected over the umbones, one or more dorsal accessory plates ; hinge teeth and ligament absent, but its place taken by an anterior apophysis, proceeding from the umbonal cavity. Under this family two species are recorded from the Bombay coast—(i) *Pholas bakeri* Desh (Fig. 81. Pl. IV) (*P. (Barnea) bakeri* Desh—Mel & Ab ; *Barnea birmanica* Phil=*Pholas bakeri* Wood—Gravelly). (ii) *Martesia striata* Lin.

In addition to these species which are fairly common, another species, *Pholas orientalis* Gmelin (*P. (Monothyra) orientalis*—Gravelly) is also equally abundant here, but not recorded previously. In size, colour and habitat it agrees with *P. bakeri* very closely but differs from it in the sculpture which 'stops abruptly leaving an extensive smooth area behind'.

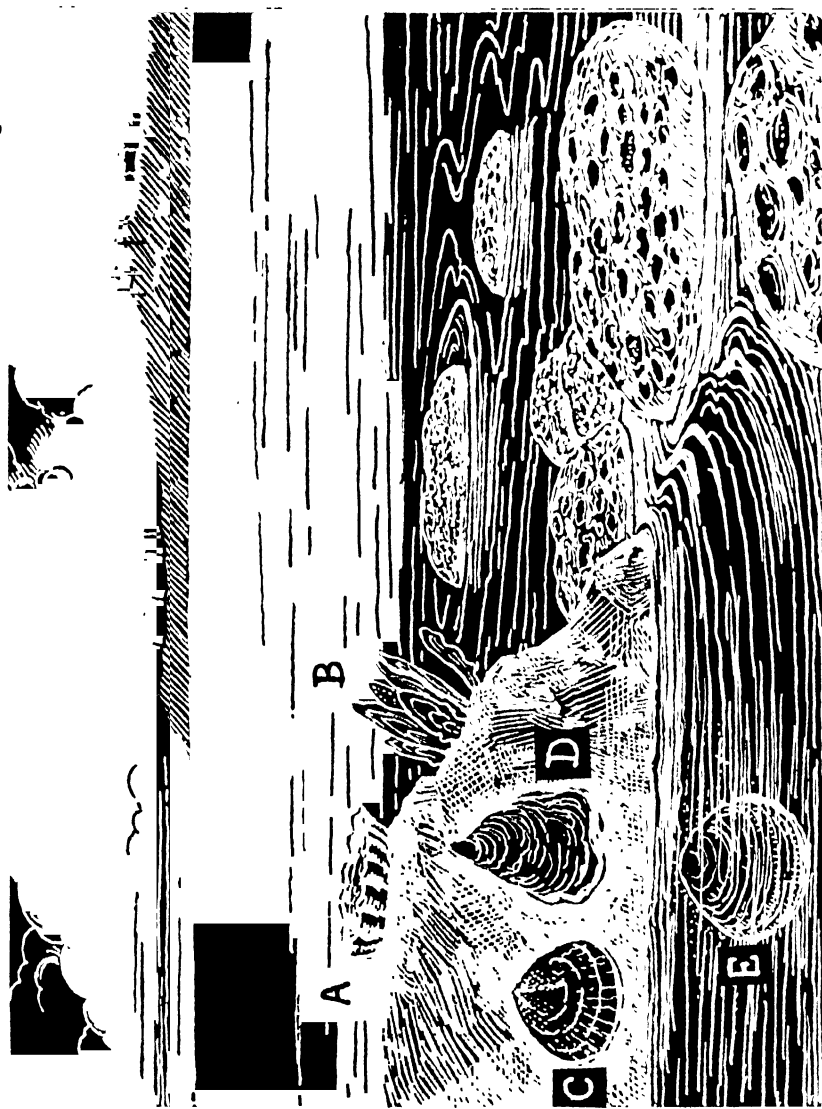
29. *PANDORIDAE* : The family is represented by a single common species. *Pandora flexuosa* Sowerby (Fig. 76. Pl. V). Its shell is small, snouted behind, resembling a canine tooth, pearly inside, left valve convex, right valve flat ; ligament with small internal nodule in a groove diverted obliquely ; pallial line with slight sinus. The left valves are very abundant in shingle.

30. *THRACIDAE* : The only Bombay species recorded under this family is *Thracia salsettensis* Mel. It is a thin trapezoid shell, fairly large and with concentric wavy grooves. Generally seen wafted along with scum to the shore by waves.

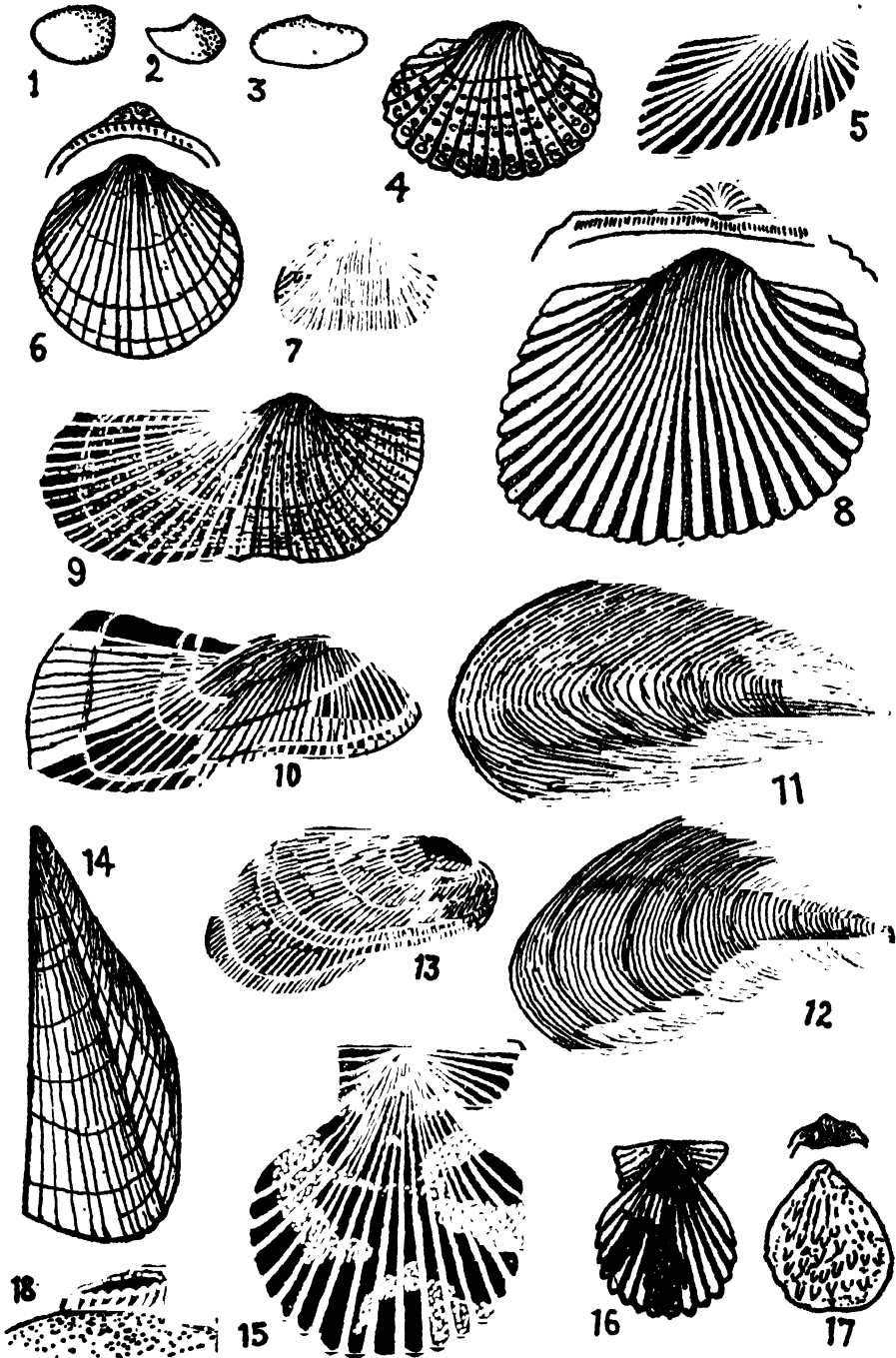
31. *LATERNULIDAE* : The Bombay representative of this family is *Laternula labiata* Reeve (Fig. 75. Pl. V) (*Anatina labiata*—Mel & Ab). A very thin, fragile and colourless shell, gaping widely, inside iridescent, ridged at the umbo ; surface somewhat rough to the touch. Very commonly found attached to sea-weeds cast ashore by waves.

REFERENCES

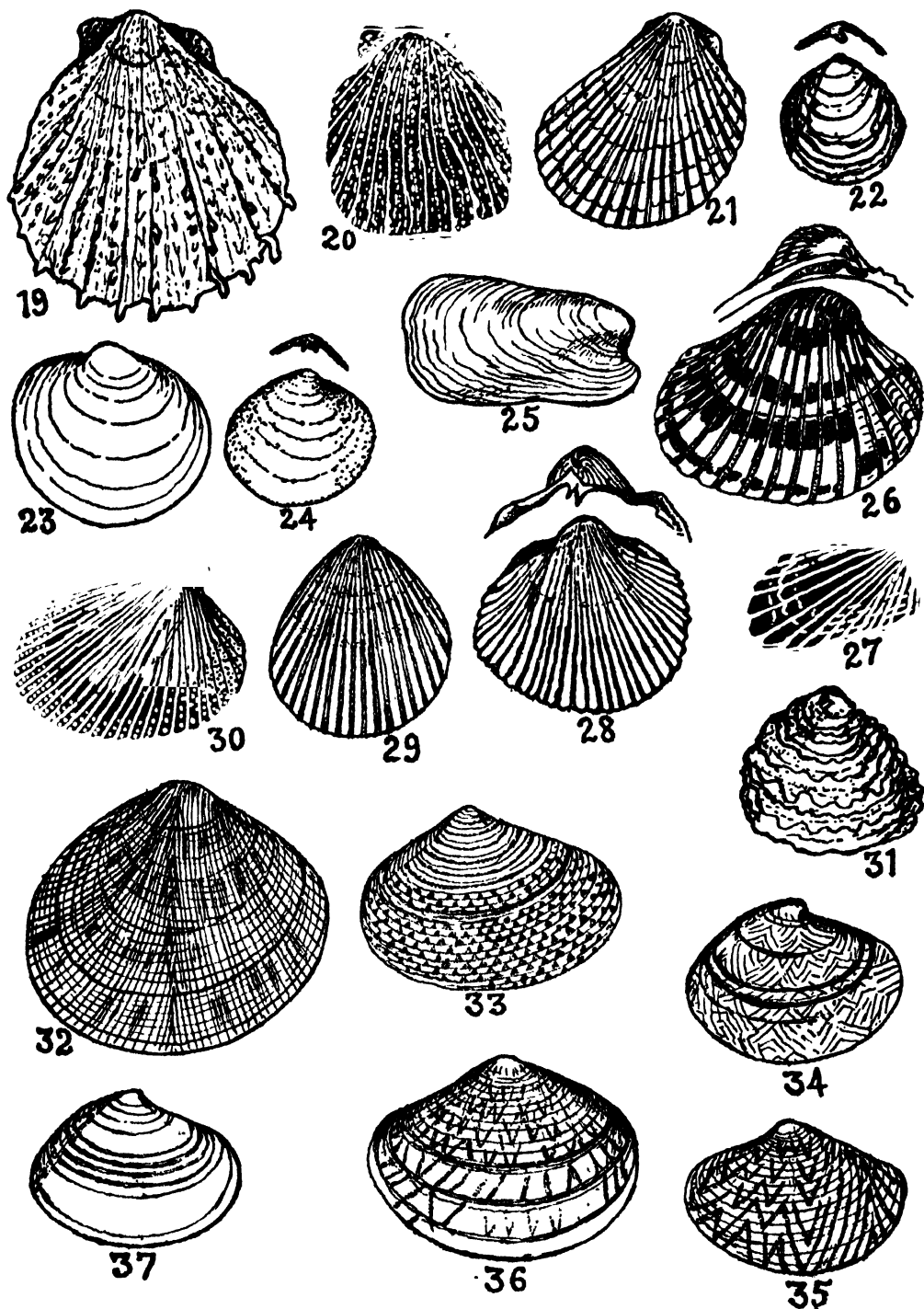
1. Harmer, S. F. & Shipley, A. E., 1895. "The Cambridge Natural History." Vol. III, Mollusca—by Cook A. H. Macmillan & Co., London.
2. Gravely, F. H., 1941. "Shells and other animal remains found on the Madras beach." Bull. Madras Govt. Mus., Vol. V, No. 1.
3. Lankester, E. R., 1906. "Treatise on Zoology." Part V, Mollusca—by P. Pelseneer. Adam & Charles Black, London.
4. Melvill, J. C. & Abercrombie, A., 1893. "The Marine Mollusca of Bombay." Proc. Lit. & Phil. Soc., Manchester.
5. Melvill, J. C. & Standen, R., 1906. "Mollusca of the Persian Gulf, Gulf of Oman and Arabian Sea." Proc. Zool. Soc., London.
6. Prashad, B., 1932. "Lamellibranchia of the Siboga Expedition. Systematic Part I—Pelecypoda." Published by E. J. Brill of Lieden.



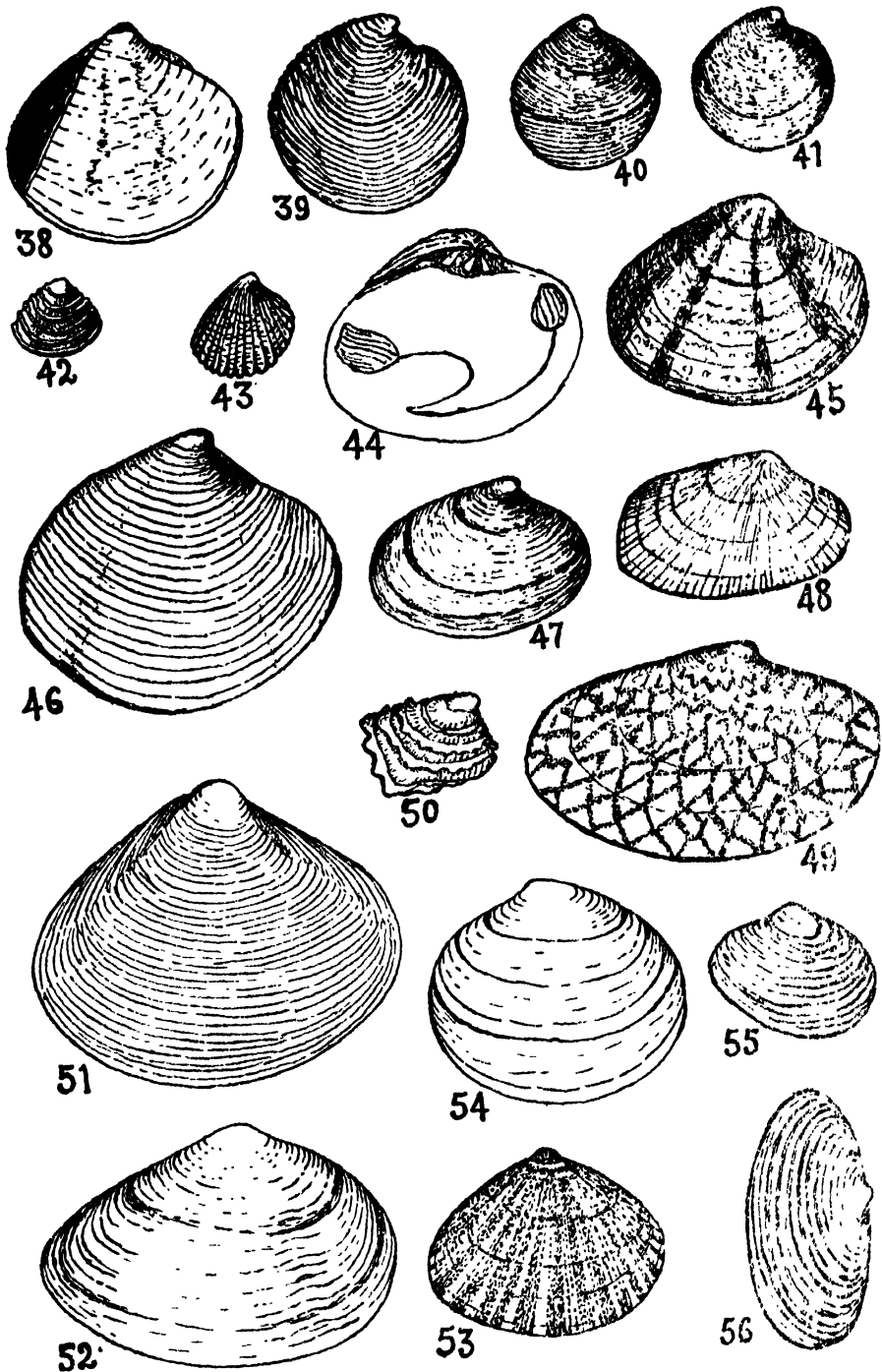
A. *Ostrea crenulifera*. B. *Ostrea lacerata*.
 C. *Anomia achaeus*. D. *Ostrea bicolor*.
 E. Placenta placenta.



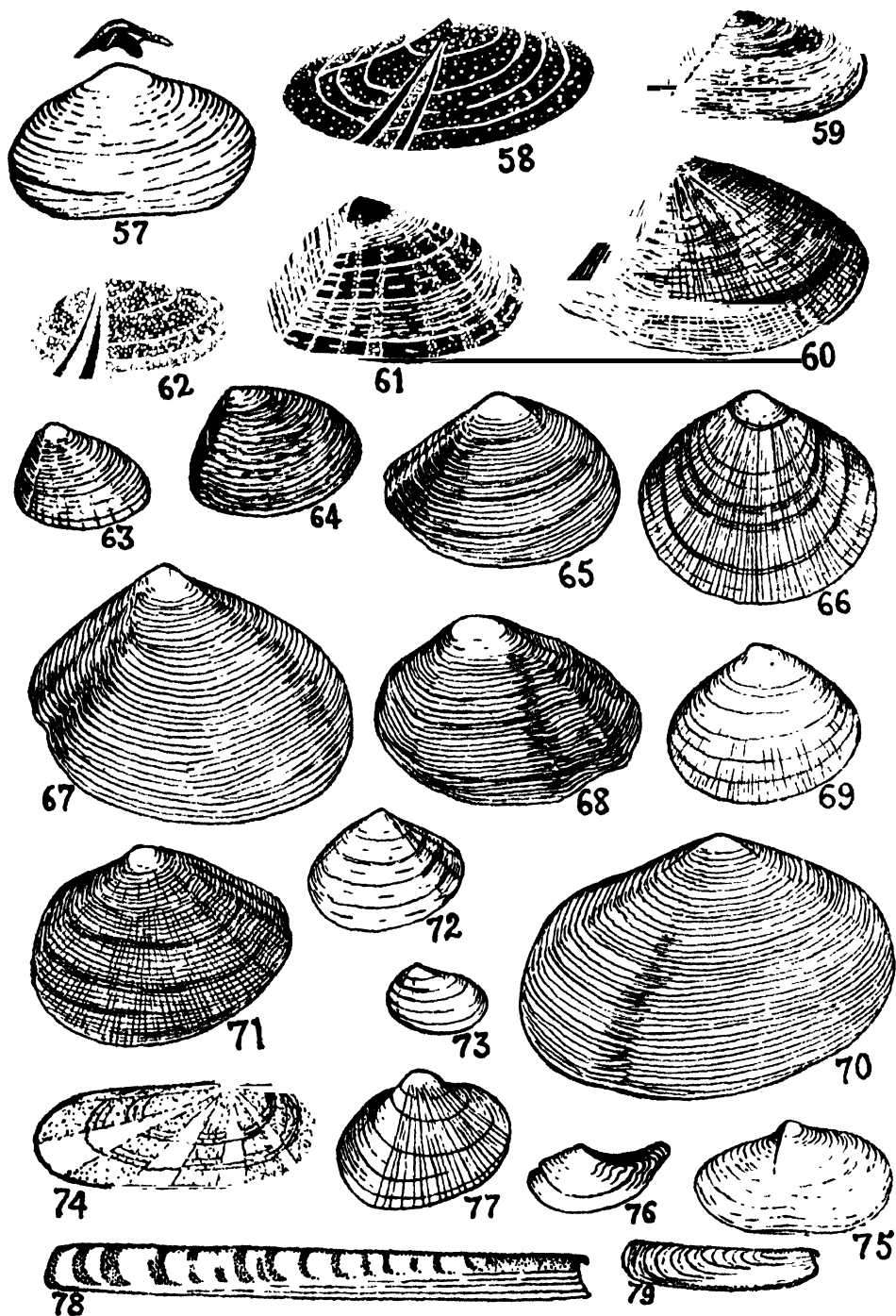
1. *Nucula layardi*. 2. *Nuculana mauritiana*. 3. *Yoldia nicobarica*. 4. *Arca granosa*. 5. *Arca obliquata*. 6. *Glycymeris* (*Pectunculus*) Sp. 7. *Arca symmetrica*. 8. *Arca inequivalvis*. 9. *Arca bistrigata*. 10. *Arca tortuosa*. 11. *Mytilus viridis*. 12. *Modiolus emarginatus*. 13. *Brachyodontes karachiensis*. 14. *Pinna nigra*. 15. *Chlamys singaporina*. 16. *Chlamys tranquebarius*. 17-18. *Plicatula ramosa*?



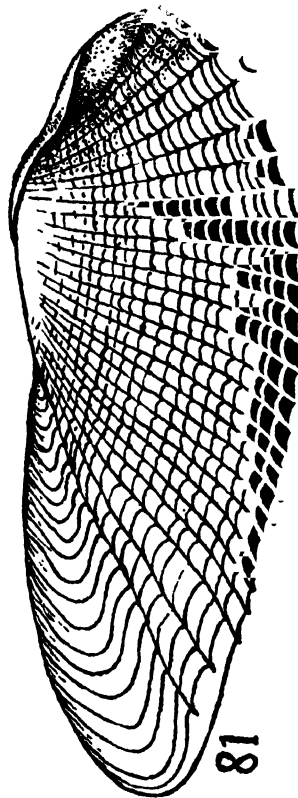
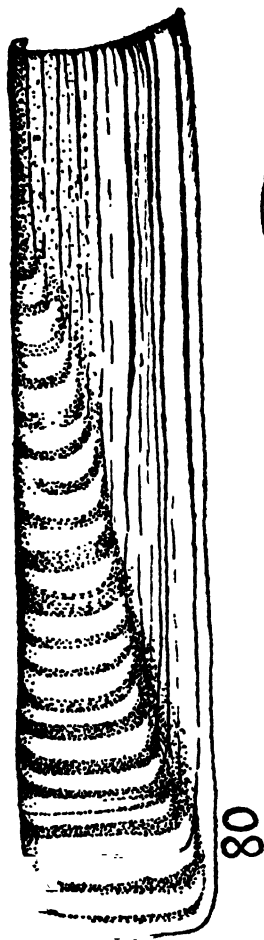
19. *Spondylus hystrix*. 20. *Spondylus rubicundus*. 21. *Lima lima*. 22. *Lucina fibula*. 23. *Diplodonta rotundata*. 24. *Diplodonta indica*. 25. *Trapezium velli-catum*. 26. *Cardita antiquata*. 27. *Cardita calyculata*. 28. *Cardium asiaticum*. 29. *Cardium oxygonum*. 30. *Cardium latum*. 31. *Chama macrophylla*. 32. *Gafra-rium divaricatum*. 33. *Sunetta meroc*. 34. *Sunetta scripta*. 35. *Sunetta effossa*. 36. *Sunetta donacina*. 37. *Sunetta solandri*.



38. *Meretrix meretrix*. 39. *Dosinia prostrata*. 40. *Dosinia excisa*. 41. *Dosinia pubescens*. 42. *Chione calophylla*. 43. *Chione imbricata*. 44-45. *Katelsysia opima*. 46. *Paphia malabarica*. 47. *Katelsysia marmorata*. 48. *Paphia indica*. 49. *Paphia textile*. 50. *Venerupis macrophylla*. 51. *Mactra cornea*. 52. *Standella pellucida*. 53. *Mactra mera*. 54. *Standella capillacea*. 55. *Racta abercrombiei*. 56. *Lutraria planata*.



57. *Coecella transversalis*. 58. *Soletellina diplos*. 59. *Gari amethystus*. 60. *Donax scortum*. 61. *Donax cuneatus*. 62. *Soletellina atrata*. 63. *Donax incarnatus*. 64. *Donax abbreviatus*. 65. *Macoma ala*. 66. *Semele cordiformis*. 67. *Macoma truncata*. 68. *Gastrana polygona*. 69. *Macoma bruguieri*. 70. *Angulus sinuata*. 71. *Arcopagia capsoides*. 72. *Angulus rubra*. 73. *Angulus lechriogramma*. 74. *Siliqua radiata*. 75. *Laternula labiata*. 76. *Pandora flexuosa*. 77. *Cryptomya philippinarum*. 78. *Solen linearis*. 79. *Cultellus cultellus*.



80. *Solen truncatus*. 81. *Pholas bakeri*.

STUDIES IN THE BACTERIAL HYDROLYSIS OF STARCH

BY NERGISH MAHOMED AND J. V. BHAT

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BECAUSE of their importance in industry the amylolytic fungi have attracted the attention of the microbiologist and the industrialist alike. Yet, beyond a species or two, the bacteria have not been exploited in this respect and therefore a survey with regard to the amylolytic action of bacteria on starch was carried out here with the results reported below.

Amylolytic bacteria were isolated from (1) the coral roots of plants belonging to the family *Cycadaceae* (1944), (2) cotton pods of *Gossampinus malabarica* (1946), (3) milk products (1947), (4) Indian pickles (1948), (5) conji water (rice gruel) and (6) soil ; enrichment culture methods by utilizing wheat starch, beaten rice (*powae*) and potatoes with the routine culture methods were employed for these isolations. The cultures so isolated were carefully identified by reference to the Bergey's Manual (1939). All the isolates were found to belong to the aerobic, spore forming group of bacteria, viz. the genus *Bacillus*.

The bacilli were then specifically tested for their amylolytic activity. By putting to test several media and methods recommended for the purpose, the authors came to the conclusion that peptone water with 0.2% to 1.0% starch (1927) as the most suitable medium. The above medium on solidification with 2.5% agar, and on further rendering more opaque with a maximum of 4% starch provided an excellent medium to follow the hydrolysis. On this medium the zone of hydrolysis around the bacterial colonies (against the opaque background) was clear-cut and often measurable. Flooding of the medium with weak iodine solution at the end of the incubation period was another additional help in studying hydrolysis where it was not clear before.

The hydrolysis of starch upto four days of incubation was followed by noting the zone of clearing around the colony and the capacity of the peptone water cultures in reducing the Fehling solution. The relative amounts of Cu_2O formed from the reagent was observed to be valuable in determining the relative degree of hydrolysis, and duplicate results could be obtained with the same set of organisms. After four days and upto the ninth day, acid production was regarded as an index, and this was also, with good approximation, observed to be a reliable measure of activity. "Soluble starch" supplied by bacteriological laboratories was not preferred as it is a partly hydrolyzed product.

The presence or absence of cellulolytic enzyme was also determined at the same time by appropriate tests to ascertain if any of these bacteria contain this enzyme ; for, in case they are to be utilized in the textile or similar industry, the cellulolytic enzyme would be a serious disadvantage. In all the tests, suitable controls were maintained to yield strongly positive and negative results. The following table summarizes the results obtained.

Species	No. of strains tested	Source*	Activity	
			Amylolytic	Cellulolytic
<i>B. bredemanni</i>	4	1,2,4,6	++	—
<i>B. amylolyticus</i> (A variant)	3	1,2,5	++++	—
<i>B. palustris</i>	3	1,2,4	+	—
<i>B. subtilis</i>	5	2,4,5,6	++++	—
<i>B. macerans</i>	1	5	++++	?
<i>B. megatherium</i>	3	3,5,6	++++	—
<i>B. silvaticus</i>	1	6	++++	—
<i>B. malabarensis</i>	1	6	+	—
<i>B. esterificans</i>	1	3	++++	—
<i>B. cohaerans</i>	1	3	++++	—
<i>B. platus</i>	5	4	++++	—
<i>B. agri</i>	4	4	++++	—

* See the text.

REFERENCES

- Bergey, D. H., *et al.* (1939) Manual of Determinative Bacteriology 5th Ed. Williams & Wilkins Co.
- Eckford, M. O. (1927) Amer. Jour. Hyg., 7, 201.
- Fernandes, F. (1944) Thesis, Bombay University.
- Mahomed, N. G. (1946) Thesis, Bombay University.
- Raghunath, M. V. (1948) Thesis, Bombay University.
- Sethna, K. F. (1947) Thesis, Bombay University.

STUDIES ON THE INFLUENCE OF SOME BACTERIAL CULTURES IN THE NITROGEN STATUS OF SOIL

4. The Influence of *Aerobacter aerogenes* in the Nitrogen Status of Soil

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THE selection of *Aerobacter aerogenes* for studying its influence in the nitrogen status of soil is likely to be a matter for arguments when we take into consideration the existence of a large number of species usually referred to as organisms of the gastro-intestinal tract. But this argument is answerable with ease inasmuch as this bacterium, in the first instance, is a very widely distributed species and unlike many other organisms of the intestinal origin does not get destroyed in the soil as a result of the antagonistic action of the native soil micro-flora. Secondly, in the soil on which these studies were carried out, this bacterium was observed to be one of the most predominant of the flora isolated. Moreover, the revelation by Chen and Rettger (1920) that out of the 467 strains of bacteria isolated by them from various soils 430 were identified as *A. aerogenes* (the rest constituting *A. cloacae* and *E. coli* types) is proof positive of the ubiquitous nature of this species. Besides being present in soil, grain and the intestinal tract, the organism possesses very many interesting properties which have been the subject of detailed investigations during the past few years. Skinner (1928), for instance, has shown that though not all, a great proportion of *A. aerogenes* strains are capable of fixing nitrogen. Selim (1931) has pointed out that this bacterium has the power of fixing appreciable amounts of atmospheric nitrogen especially when freshly isolated from soil. Lohnis and Hensen (1921) had remarked earlier that the nodule bacteria do not represent a special genus *Rhizobium*, but are clearly related to *Alcaligenes radiobacter*, *Alcaligenes viscosus*, *Aerobacter aerogenes* and *Klebsiella pneumoniae*. All these findings go to indicate the significance of this bacterium in the microbial population of the soil.

It is also of interest to mention in this connection that a large number of simple nitrogen and carbon compounds can serve as metabolites for *A. aerogenes*, and this indeed is a pointer to its extreme adaptability and distribution. The bacterium, as is well known, has a pH adjusting mechanism as well, and this enables it to change its enzyme complex besuited to the conditions under which it is subjected. These and various other characteristics of the organism were bidding for its inclusion in the list of bacteria subjected to these studies and, as the following pages will reveal, *A. aerogenes* has indeed its own part to play in the nitrogen metabolism of the soil.

The experimental procedures followed and the methods adopted have already been detailed out in the previous papers published in this Journal (1948). In the following experiments, the "inoculated" series of flasks each containing 5 gm. of the soil were inoculated with 0.1 cc. of a saline suspension of *A. aerogenes* (approximately 265,100,000 cells/cc.) and exposed to the various light-weather conditions for 30 days as before and analysed for their nitrogen contents and the viability of the inoculated bacterium. The results obtained are presented below.

1. DIRECT SUNLIGHT

Losses in Nitrogen contents expressed in p.p.m. of the soil. The + sign before the figures indicates a gain in Nitrogen.

Moisture condition of the soil	Inoculated set		Sterile set	
	Total N.	Soluble N.	Total N.	Soluble N.
Dry	154.00	+44.00	105.40	30.34
Semi-saturated	+43.63	+108.60	64.12	10.40
Water logged	110.04	+87.64	53.78	38.00

Conclusions.—The bacterial action on the soil nitrogen is at once evidenced from the losses indicated in the total nitrogen of the dry samples. The loss in the insoluble nitrogen is appreciable (approximately 50 p.p.m.) and is interesting inasmuch as this bacterium is described as "not liquefying gelatine." This loss in the insoluble nitrogen has therefore to be accounted for as due to the action of endotrypsin liberated from the cells after their death and subsequent deterioration, which indeed does occur under the conditions. The organism, however, remained viable even in the dry soil for 30 days and produced appreciable quantities of soluble nitrogen in all the samples. (See table above, column 3). The gain in the total of the semi-saturated "inoculated" sample with the correspondingly higher gain in the soluble nitrogen is conclusive of the nitrogen fixing properties of the bacterium. At the same time the appreciable loss in the total nitrogen of the water logged with only a small gain in the soluble nitrogen is suggestive that in some way nitrogen gets depleted as a result of the bacterial activity. This organism is described as a reducer of nitrate to nitrite only, but this does not warrant a further reduction. But it is probable that under water logged conditions in the soil the nitrataase activity is further extended to result in the loss of this important element to soil. However, the important point that emerges from these experiments is that the presence of this organism is beneficial to the soil from the point of view of the increase in its soluble nitrogen contents.

2. DIFFUSED LIGHT

Losses in Nitrogen contents expressed in p.p.m. of the soil. The + sign before the figures indicates a gain in Nitrogen.

Moisture condition of the soil	Inoculated set		Sterile set	
	Total N.	Soluble N.	Total N.	Soluble N.
Dry	154·00	+108·60	87·04	60·68
Semi-saturated	+21·56	+44·00	44·24	24·26
Water logged	44·24	+131·60	129·40	24·26

Conclusions.—That *A. aerogenes* has a depletory action on soil nitrogen is emphasized here when we see the results obtained for the total nitrogen of the dry samples. This action, however, results in the transformation of some of the insoluble nitrogen into a soluble form, and this is evidenced from the considerable gain recorded for the soluble nitrogen. When we examine the results obtained for the semi-saturated samples, on the other hand, we observe with interest that this organism is endowed with nitrogen fixing capacity. For despite a loss of over 64 p. p. m. of total nitrogen in the sterile sample, we observe a clear gain of 43·68 parts of nitrogen over that initially recorded for the total : this means that over 107 p. p. m. of nitrogen has been accumulated during the course of 30 days. It is, however, curious in this instance that the actual gain registered in the soluble nitrogen is only 44 parts against the calculated 107 parts. Undoubtedly, many more factors are involved in the cycle of nitrogen in the soil than we have been able to explain. The results obtained for the water logged samples, nevertheless leave no doubt in our mind that nitrogen fixation is a vital factor, and that water exerts its own specific influence (see sterile sample for total nitrogen) on the nitrogen status of soil. Besides these, we have to reckon the role of the gases of the atmosphere, light, heat, evaporation and other factors still undetermined. It is interesting to note here that the gain recorded for the water soluble is the highest in this instance, and that too despite the possible depletory activity of this bacterium under the conditions of the experiment. On the whole it is safe to presume that the presence of *A. aerogenes* in soil is valuable to the soil from the point of view of increase in soluble nitrogen.

3. DARKNESS

Losses in Nitrogen contents expressed in p.p.m. of the soil. The + sign before the figures indicates a gain in Nitrogen.

Moisture condition of the soil	Inoculated set		Sterile set	
	Total N.	Soluble N.	Total N.	Soluble N.
Dry	+10·64	+99·40	50·66	18·88
Semi-saturated	+21·56	+108·60	186·56	56·28
Water logged	154·00	+87·64	106·00	24·26

Conclusions.—Generally speaking, darkness appears to be the most favourable condition for the accumulation of nitrogen in soil when *A. aerogenes* is the sole existing species in it. Gain in both soluble and insoluble nitrogen is recorded in the “inoculated” samples of the dry and semi-saturated sets: the slight loss observable in the water logged (for the total nitrogen) is, so to speak, compensated by the gain recorded in the soluble nitrogen. That nitrogen fixation can and does take place in soil as a result of the activities of *A. aerogenes* is more than apparent from all these results. The presence of moisture and absence of direct sunlight appear to be rather conducive factors for the increase in the nitrogen level in general.

SUMMARY

1. Even though regarded as a non-proteolytic type, *A. aerogenes* exerts its influence on the insoluble nitrogen of soil and converts it into soluble form or brings about a loss of this element to soil.

2. *A. aerogenes* definitely has the capacity of increasing the nitrogen levels in soil and this is presumably due to its nitrogen fixing property.

3. Diffused light and darkness appear to be more favourable for this increase in nitrogen than direct sunlight.

4. Moisture has a favourable influence on the soil nitrogen when the soil is charged with *A. aerogenes*.

REFERENCES

- Bhat, J. V., and Palacios, G. (1948) Jour. Univ. Bombay, 16, part 5B, 15.
Idem. (1948) *Ibid.* 16, part 5B, 23.
Idem. (1948) *Ibid.* 17, part 3B, *in press.*
 Chen, C. C., and Rettger, L. F. (1920) Jour. Bact., 5, 253.
 Lohnis, F., and Hensen, R. J. (1921) Jour. Agri. Res., 20, 543.
 Selim, M. (1931) Centrabl. Bakt. II, 89, 311.
 Skinner, C. I. (1928) Soil Science, 25, 195.

BOOKS RECEIVED

Alga Olaus Gracilaria in Australia by V. May. Bulletin No. 235, Council for Scientific and Industrial Research, Commonwealth of Australia.

On the Development and Morphology of the Skeleton of the Head of Petromyzon, by Alf. G. Johnell, Stockholm, 1948.

Oxford Medical Publications and Other Works on Medicine, Surgery and Associated Subjects—Condensed List, 1948.

Report of the Indian Drugs Research Association, Poona for 1948.

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